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ARMY RESEARCH OFFICE

BROAD AGENCY ANNOUNCEMENT

SCIENCE TO SHAPE THE FUTURE OF THE ARMY
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INTRODUCTION

This Broad Agency Announcement (BAA) sets forth research areas of interest to the Army Research Office (ARO) and is issued under the provisions of paragraph 6.102(d)(2) of the Federal Acquisition Regulation (FAR), which provides for the competitive selection of basic research proposals. Proposals submitted in response to this BAA that are selected for award are considered to be the result of full and open competition and in full compliance with the provision of Public Law 98-369, "The Competition in Contracting Act of 1984."

Research proposals are sought from educational institutions, nonprofit organizations, and private industry for research in biosciences, chemistry, physics, engineering, and electronics, and materials, mathematical, computer, and environmental sciences. This BAA is intended to cover, in a general nature, all research areas of interest to ARO. Prospective offerors contemplating submission of a proposal are encouraged to contact the appropriate ARO program manager/scientist identified in Part I of this publication to ascertain the extent of interest in the specific research project. Their telephone numbers and e-mail addresses are on page 5. In addition, proposals for comprehensive and interdisciplinary research programs will be considered. However, only a small number of these large programs can be initiated in a single fiscal year. Inquiries related to comprehensive and interdisciplinary programs should be sent to the Director of ARO.

Part II, Special Programs, discusses ARO's contribution to conferences and symposia, the Young Investigator Program (YIP), the Presidential Early Career Award for Scientists and Engineers (PECASE), the Short Term Innovative Research (STIR) Program, the Research Instrumentation Program (RIP), and ARO's interest in Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs).

The ARO contributes support to a limited number of scientific conferences and symposia in special areas of science that bring experts together to discuss recent research or educational findings.

The YIP and PECASE provide research opportunities for outstanding young university faculty members and enhances their research interests and capabilities.

The STIR is a mechanism for private industry, institutions of higher education, and nonprofit organizations to advance an innovative scientific or technical research idea or to continue as an outgrowth previous experimental or theoretical exploration on a short term basis.

The RIP allows U.S. universities to improve their capabilities of conducting research and educating scientists and engineers in areas of importance to the national defense.

ARO has a long history of supporting research at historically black colleges and universities and minority institutions. We actively seek quality research proposals from HBCUs and MIs in full competition with all offerors who may submit proposals under this BAA. Such proposals may be submitted at any time. We also encourage the inclusion of HBCUs and/or MIs as part of a consortium proposal or as subcontractors/subgrantees to prime recipients.

Under the programs covered by this BAA, the ARO receives approximately 700 proposals each year and historically funds approximately 200 new awards.

In accordance with federal statutes, regulations, and Department of Defense (DOD) and Army policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from ARO.

This BAA consists of five parts as follows:

Part I - ARO Research Interests
Part II - Special Programs
Part III - Proposal Evaluation
Part IV - Proposal Preparation
Part V - Proposal Forms

Offerors submitting proposals are cautioned that only a Contracting or Grants Officer may obligate the Government to any agreement involving expenditure of Government funds.

This BAA also applies to research proposals submitted from Europe, Africa, Middle East, and Southwest Asia to the U.S. Army's European Research Office.

Please note that ARO prefers that proposals submitted in response to this BAA cover a 3-year period and include a brief summary of work contemplated for each 12-month period so that awards may be negotiated from an entire 3-year program or for individual 1-year increments of the total program.

All administrative inquiries regarding this BAA shall be addressed to voice mailbox number 919-549-4375. If an inquiry is made, please clearly state your name and the correct spelling.

This BAA is available on the ARO HomePage at http://www.aro.army.mil/index.htm.

This BAA is a continuously open announcement valid throughout the period 1 October 1998 through 30 September 2001 (Fiscal Years 1999-2001), unless announced otherwise, and supersedes the ARO BAA dated October 1997.

PART I

ARO
RESEARCH
INTERESTS

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BIOSCIENCES

I. INTRODUCTION

II. RESEARCH AREAS

A. Biomolecular and Cellular Materials and Processes

B. Microbiology and Biodegradation

C. Physiology, Survivability, and Performance

BIOSCIENCES

I. INTRODUCTION

The U.S. Army Research Office (ARO) supports extramural research in the biosciences. For those proposals related to purely medical topics, the investigator is invited to contact the U.S. Army Medical Research and Materiel Command. For research in the behavioral and social sciences or in training techniques, contact the Army Research Institute for Behavioral and Social Sciences.

The ARO Biosciences research program is currently focused on the areas described below. If you desire further information, or if you have research ideas that you wish to bring to our attention, please contact the program manager identified. We prefer that you submit a short, informal pre-proposal of your ideas (1-2 pages). This will be evaluated in terms of Army interest and suitability for submission as a full proposal. This informal "white paper" should include research objectives and an experimental plan or method of approach. A small number of symposia, conferences, and workshops are also supported in part or in whole to provide an exchange of ideas related to ongoing programs in Army laboratories.

II. RESEARCH AREAS

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

A. Biomolecular and Cellular Materials and Processes (Dr. Robert J. Campbell)

Fundamental studies to define structure-function relationships and biochemical interactions for enzymes, receptors and other macromolecules exhibiting mechanisms and properties uniquely relevant to synthetic and degradative pathways of interest to the military, including establishment of the foundations for manipulation and exploitation of biocatalysis, ribosomal and non-ribosomal biosynthesis to enhance permissiveness toward elaboration of useful biomolecular structures and cellular systems designed with "metabolic engineering" in mind.

Basic research to provide insight from nature on novel theoretical principles and mechanisms in sensory and motor function, as well as on materials with extraordinary properties, from biological sources. Included are not only initial molecular events, signal transduction pathways and integrated information processing for the powerful sensing capabilities exhibited in the biological world, but also self-assembly processes, hierarchical structure formation, and functional characterization of biomolecular materials such as those with potential "biomimetic" utility for nanometer scale fabrication or for energy and information transfer, among other possibilities.

B. Microbiology and Biodegradation (Dr. Shirley R. Tove)

Basic research on the biochemical and physiological mechanisms underlying the biodegradative processes in normal, extreme, and engineered environments; basic studies on organisms from extreme environments; the properties of materials that make them susceptible or resistant to biological attack; basic concepts for anti-fungals; mechanisms for the remediation of contaminated sites; analytical microbiology, including microbial signatures; and general microbial mechanisms with relevance to Army problems. Research into microbial communities and how to study organisms that cannot be grown in the lab. Research into methods to enhance the stabilization of military materiel that would include methods to prevent microbial growth.

C. Physiology, Survivability, and Performance (Dr. Donna M. Cookmeyer)

Basic research on how organisms respond and adapt to environmental signals and the strategies they employ to survive adverse environmental conditions. More generally, research pertaining to how organisms respond to and cope with stresses of various kinds, positively or negatively, at the molecular, cellular, or organismal level. Basic research to identify the molecular and genetic basis of adaptative behaviors, such as hibernation and sleep, and their long term potential for application to the improvement of human performance and survivability. Also, as a way of accessing previously unknown or uncharacterized cellular processes related to physiology and/or homeostasis, basic research in the area of host (primarily plants and lower organisms) response to viral invasion, as well as research on how viruses usurp existing host resources and capabilities. Research in other areas that show long term potential for reducing the degradation of human performance during extended operations and/or under adverse conditions, or for improving overall performance and survivability.

CHEMISTRY

I. INTRODUCTION

II. RESEARCH AREAS

A. Analytical Chemistry

B. Chemical Kinetics

C. Electrochemistry and Advanced Energy Conversion

D. Organic Chemistry

E. Polymer Chemistry

F. Surface and Interfacial Chemistry

G. Theoretical Chemistry

CHEMISTRY

I. INTRODUCTION

Chemistry is central to the operation of the Army. Explosives, propellants, fuel cells, and batteries function by converting chemical energy into mechanical and electrical energy. Macromolecules, especially elastomers, provide materials for equipment. Protection of the soldier against chemical agents requires the detection, identification, and destruction of such chemicals, and the design and construction of barriers to their passage. The destruction of toxic wastes represents another chemical problem faced in the restoration of military real estate and the safe demilitarization of surplus munitions.

We invite proposals for research to advance our understanding of chemical materials and processes with a strong prospect for use in future Army technology. We prefer that interested applicants first submit a short (1-2 page), informal description of their ideas so that we can determine whether submission of a formal proposal would be appropriate. The following descriptions of topical areas are representative of our interests but are not exhaustive.

II. RESEARCH AREAS

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

A. Analytical Chemistry (Dr. Douglas J. Kiserow)

The detection and identification of chemical agents, explosives, and chemical contaminants is of interest to the Army on the battlefield and for environmental applications. Research areas include novel detection and identification schemes, small lightweight sensors, multidimensional analytical techniques, and predictive and interpretive models. Proposals in this area will only be considered for basic research that is connected with specific Army research programs.

B. Chemical Kinetics (Dr. Robert W. Shaw)

The Army's program in ignition and combustion processes associated with energetic materials, explosives, detonation phenomena, the control of energy release and energy transfer processes will benefit from increased understanding of fast reactions of energetic species. We are especially interested in the investigation of chemical reactions using time-resolved techniques to observe transient species and infer reaction pathways and other experiments and calculations that enable modeling of the time dependent processes of ignition and combustion. Research on controlled transformation of toxic materials to relatively benign products in chemical reactors is also of interest.

C. Electrochemistry and Advanced Energy Conversion (Dr. Richard J. Paur)

The Army relies on compact power sources to support many different weapons systems, communications, and other devices. Power sources under development include batteries and fuel cells, microturbines, thermophotovoltaics, alkali metal thermal to electric converters. This program supports fundamental chemical studies of materials and processes that limit the performance of current or enable future power sources. Topics include ionic conduction in electrolytes, electrocatalysis, fuel processing (particularly hydrogen), interfacial electron transfer, transport through coatings, surface films and polymer electrolytes, and activation of carbon-hydrogen bonds. Novel electrochemical synthesis, investigations into the effect of microenvironment on chemical reactivity, and quantitative models of electrochemical systems are also encouraged.

Electrochemical phenomena provide the Army with power (fuel cells, batteries) and a wide range of materials and devices (coatings and films, microelectronics, chemical sensors). We support research leading to quantitatively reliable models of electrochemical systems including studies of charge transfer and adsorption phenomena at electrified interfaces; transport through coatings, surface films and polymer electrolytes; extended structure of interfacial regions and electrodeposition mechanisms and morphology studies; electrocatalysis; and electrosynthesis. electron transfer reactions are also of interest, and we encourage investigations into the effect of microenvironment on chemical reactivity.

D. **Organic Chemistry** (Dr. Stephen Lee)

Molecules targeted for special attention include pigments and dyes with emission and reflectance characteristics useful for camouflage and controlled signature applications, potentially important monomers, especially for preparation of elastomer barrier materials and polymer electrolytes. New, more efficient, and environmentally benign organic reactions, both stoichiometric and catalytic, are of interest, especially nitration, and oxidative and nucleophilic displacements at phosphorus and sulfur for destruction of toxic organic compounds. Selected mechanistic studies that promise new insights to the pathways of the above reactions are encouraged as are new synthetic pathways with reduced production of waste byproducts.

E. **Polymer Chemistry** (Dr. Douglas J. Kiserow)

Polymeric materials are of critical importance to the Army for soldier protection and materiel. This program supports molecular level polymer research leading to new polymeric materials that are chemical resistant, have selective permeability, are resistant to environmental changes, and have reduced weight with increased strength. Research areas of current interest include synthesis of new polymers, molecular property studies, computational modeling, self assembly, molecular architecture, and dendritic molecules.

F. **Surface and Interfacial Chemistry** (Dr. Stephen Lee)

This program supports research on the decomposition of hazardous molecules on well-characterized surfaces, and in organized media (e.g. micelles, microemulsions, vesicles, and monolayer films) at liquid-liquid and liquid-solid interfaces. The development of new experimental probes of these reactions is also of interest. The most important species are organo-phosphorus, -sulfur, and -nitrogen molecules, and reactions of organic functional groups on surfaces and in these organized media. The principle reactions of interest are hydrolysis and oxidation, and catalysis is a strongly desired goal of these studies; however, new concepts are encouraged. We also encourage studies of erosion of metal and other surfaces by combustion gases.

G. **Theoretical Chemistry** (Dr. Robert W. Shaw)

Army requirements for insensitive munitions, for propellants and explosives with greater energy density, for the control of propellant burning rates, and controlled energy release from explosives provide a continuing interest in a variety of theoretical explorations. Theoretical investigations may provide predictive capabilities relevant to the properties and behavior of a wide spectrum of energetic materials and their prototypes. More specifically: studies of energy transfer mechanisms in condensed phases, the prediction of molecular reactivities, the investigation of heterogeneous reactions, and the prediction of reaction pathways. Theoretical understanding of atoms, molecules, and clusters on surfaces may provide the basis for rational design of catalysts.

ELECTRONICS

I. INTRODUCTION

II. RESEARCH AREAS

A. Solid State Devices

B. Quantum and High Frequency Electronics

C. Opto-electronic Devices

D. Mobile, Wireless Communications and Networks

E. Information Processing and Fusion and Circuits

F. Minimum Energy/Low Power Electronics

G. Electromagnetics

ELECTRONICS

I. INTRODUCTION

Research in electronics is performed in the areas of *Solid State Devices* including semiconductors, magnetics, dielectrics, and circuit designs; *Quantum and High Frequency Electronics* including novel, high speed, wide bandwidth devices, terahertz electronics, and quantum devices for signal and image processing; *Optoelectronic Devices* including electro-optical devices and materials, optoelectronic components, optical communications, and optical signal processing; *Mobile, Wireless Communications and Networks,* including networking, adaptive protocols, modulation, and coding; *Information Processing and Fusion and Circuits,* including image, target, and clutter modeling, fusing information from multiple sources, and high performance architectures, adaptive and array processing, information fusion and circuits; *Minimum Energy/Low Power Electronics*, including minimum energy processing, circuit and systems design for high efficiency/low voltage, mobile systems and networks, adaptive power management, and component technologies; *Electromagnetics* including integration technologies, optically controlled millimeter-waves/microwaves, antennas, electromagnetic (EM) simulation, and propagation and scattering effects. The objective is to identify and solve critical Army research problems where progress has been inhibited by a lack of novel concepts or fundamental knowledge. Work under this task has application to a wide variety of development efforts and contributes to the solution of technology-related problems in communications, command and control, surveillance, target acquisition and night observation, intelligence, and electronic warfare. The following sections contain information on these research areas and specific research thrusts.

II. RESEARCH AREAS

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

A. Solid State Devices (Dr. Michael Stroscio, Dr. Dwight Woolard, and Dr. Mitra Dutta)

This research area includes the acquisition of basic knowledge on electronic, magnetic, and optical materials and structures for microelectronics. The Army seeks to understand those parameters of electronic materials which potentially affect or determine characteristics of future high-performance devices. To establish the science base for future Army battlefield capabilities, innovative research is sought in the general areas of advanced electronic materials, processing and fabrication science, self assembly technologies for solid state devices, advanced device concepts, nanometer-scale devices and systems electronics-based micromachined devices, ultralow power technology and integrated systems. Areas such as generation, transport and control of charge carriers in semiconductors, and electronics contributing to novel optical, electro-optical and optoelectronic systems are of interest. Specific research fields of current interest are electronic and structural properties of elemental, binary, ternary, and quaternary semiconductors; semiconductor surface and interface studies; active quasi-optical device effects at millimeter wave frequencies; as well as novel electro-optical and optoelectronic devices and interconnects.

Studies of the new or improved operating principles for semiconductor devices as well as investigations concerning the fundamental limitations of the operating range of devices will provide directions for potential improvements. Included in this research effort is the evaluation of existing device barrier problems in the fields of generation, detection and processing of electronic signals. Research in semiconductor devices is emphasized to increase the power-frequency product or the bandwidth of new classes of electronic devices and to study transit time effects on semiconductor devices.

Army electronics systems for the twenty-first century will require a four-order-of-magnitude increase in real-time signal processing capability. Requisite device speed and densities demand that the initial feature size be lowered from the current few-micron (micrometer) level, through the very high speed integrated circuits (VHSIC) domain (1.5-0.5 micron), to the ultra-submicron region (0.1 micron and below). Planned systematic technological realization of submicron and ultrasmall devices cannot be achieved without research to understand the physical laws describing bandstructure, charge transport, interaction effects, etc., in the submicron realm. Research needs at this stage may be grouped in five major problem areas: (1) carrier transport properties, non-equilibrium phenomena, and dissipative interactions, (2) electrical characterization (including picosecond characterization) of ultrasmall electronic structures, (3) electronic properties of subdimensional structures and heterojunctions, (4) novel device structures, with emphasis on nanoscale and mesoscopic devices, and (5) the coupling of ultraviolet, visible and infrared radiation to novel direct bandgap semiconductor structures. Novel devices based on mixed-mode principles portend numerous multifunctional information handling applications. Whereas many current devices depend primarily upon a single phenomenon for their operation, these new devices exploit a complexity of interactions between a variety of fields, including quasi-static electric and magnetic, electromagnetic, optical and quasi-optical, thermal, and elastic. Advanced device concepts for use on the digital battlefield are needed to include: efficient, low power components; sensing of ultraviolet, visible, and infrared radiation by semiconductor structures; terahertz device technology in the 100-1000 GHz region; optoelectronic devices for optical interconnects; micromechanical and microphotonic integrated sensors; new high temperature, high power electronics utilizing wide bandgap semiconductors, new unipolar and bipolar devices; devices based on high temperature superconducting materials; and molecular electronics. To ensure the timely insertion of ultrasmall electronics technology, program thrusts will include research on input-output coupling of nanoscale devices. Semiconductor device research will be conducted with the aim toward ultra high-speed and low-power integrated circuits.

B. Quantum and High Frequency Electronics (Dr. Mitra Dutta and Dr. Dwight Woolard)

The Army is interested in the following electronic component areas: (1) ultrafast switching transistors and optoelectronic devices for high processing bandwidths in signal and data processing, (2) monolithic ultrasubmicron device components and networks capable of application-specific signal processing, and (3) terahertz emitters, detectors, modulators, device arrays and frequency multipliers. State-of-the-art techniques for fabricating quantum-scale structures are emphasized. New device concepts based on intersubband energy level engineering is expected to emerge as potential candidates for terahertz applications. Research in novel quantum phenomena and effects of external perturbations such as strain and band coupling effects, as well novel transport effects in nanoscale electronic structures and incorporation of these effects into devices with higher functionalities which will enable the Army's next generation electronic and optoelectronic devices. Research will also include the use of these results to demonstrate proof of principle devices employing this novel phenomena and study of them to understand their operations as well as how to apply this knowledge and understand the limitations and determine their ultimate performance ranges. Research in issues relating to design, modeling, and fabrication of these device structures are of interest. Materials issues in these novel devices are also of importance for high performance, high fields and high temperature and reliablity. Research in support of these objectives includes submicron device modelling and scaling novel device structure concepts (e.g. vertical integration ballistic devices and quantum-well concepts) and submicron device fabrication for enhanced functionalities.

C. Opto-electronic Devices (Dr. Mitra Dutta)

Research on the generation, detection and control of optical signals in both semiconductor and dielectric materials is of interest. In particular, novel electro-optical processes leading to greater manipulation and increased data handling capabilities are to be considered. To establish the science base for future Army battlefield capabilities, innovative research is sought in the general areas of advanced optical materials, optical and infrared sensors, solid state, semiconductor lasers and infrared detectors, as well as optoelectronic devices and circuits. Representative areas of investigation include: (1) photonics in III-V and III-N compound semiconductors, (2) methods for altering optical and electronic properties of materials, (3) investigations of semiconductor surfaces and interfaces, (4) light emission and detection in nanostructures, and (5) rare-earth doping of semiconductors and dielectrics.

The Army requires high resolution, high sensitivity, "multicolor" infrared imaging arrays for target acquisition, recognition, and identification. Future systems need to be developed for the fusion of data from infrared (IR) sensor suites involving several wavelengths. Research opportunities include components based on quantum well and semiconductor materials operating in the 3-5, 8-12, and 18-24 microns regions as well as ultraviolet (UV) solar blind detectors and arrays. Army image processing requirements necessitate operations on a million pixels at rates up to a thousand frames/second at resolutions above twelve bits. Development of the necessary architectures and the optical processing components provide research challenges. The next generation IR imaging systems will use large area, multispectral, staring arrays with considerable front end processing to provide multi-wavelength spatial and temporal detection. New device concepts are needed for all the above applications.

High speed signal processing and computing, as well as data storage, will require advanced laser diodes, and for optical processing components and optical data storage. Research is necessary in semiconductor materials growth and device processing to improve the efficiency and reliability of the output of the devices at these wavelengths. For optical processing of images, research leading to two-dimensional (2-D) arrays of surface-emitting lasers is necessary.

As the needs for information processing become more complex, the advantages of optical interconnection techniques become very clear. Optical interconnect components are needed in guided-wave data links for computer interconnection and in free-space links for optical switching and processing. Research addressing efficient, novel optical components, such as optical electro-mechanical systems (MEMs) is needed.

Optically controlled millimeter-wave and microwave devices and circuits have significant potential application in communications and radar systems, particularly mobile systems. Of particular interest are methodologies for integrated systems generating the final radio frequency (RF) signal using an optical heterodyne principle. Low loss splitters with integral semiconductor amplifiers and the control of polarization are important. Fast optical detectors for frequencies up to 60 GHz and above, which can still handle high optical powers are required. Alternative approaches to direct detection, such as optical injection locking should be considered. Modeling and simulation techniques for the optical interactions in devices and the optical propagation through complex optical structures are needed. Technologies which foster monolithic or near monolithic electrical and optical integration are components of special interest. Efficient integration of the optoelectronic components with RF is an important consideration.

D. Mobile, Wireless Communications and Networks (Dr. William Sander)

The mobile, wireless communications and networks research program is concerned primarily with establishing the fundamental understanding necessary to support the Army's future mobile, wireless tactical battlefield communications needs. The Army is interested in communication systems operating in frequency bands traditionally occupied by narrowband radios high frequency (HF), very high frequency (VHF), and ultrahigh frequency (UHF) as well as systems operating in frequencies extending into the millimeter wave region. These systems must support broad-based and highly mobile communications "on-the-move" and must perform in environments of impressive diversity, from dense foliage to dense urban obstructions, and unintentional and intentional jamming. Research is required in broad thrust areas including end-to-end admission, flow and congestion control and reliability; adaptive routing and forwarding protocols, power control, channel access and link-layers protocols; adaptive coding and modulation techniques for power and spectral efficiency; signal processing and in modeling and simulators. Modeling of ultra wideband channels, channel parameter estimation, signal design, and coding for multiple access channels with interference is important. Many military communication systems signals have unknown or time-varying characteristics, motivating the need for research in both the theory and modeling of stochastic signals in noise and interference. There is an interest in basic research to develop theory to support the design of advanced highly mobile, multi-band multi-mode communications receiver and transmitter architectures with special emphasis given to techniques which minimize power dissipation for near optimal performance over a wide range of channels. Research is sought which supports spread spectrum, multiple access, anti-jam and covert (low probability of detection/interception) capabilities, and adaptive antenna array processing. Research in adaptive data compression and adaptive error control coding is also relevant.

Future Army tactical communication systems for the digital battlefield will consist of many different types of networks and must be capable of communicating "on the move". These systems will be highly mobile creating highly dynamic network topologies (mobile ad-hoc networks) and routing multimedia (voice, data and video) data. Some form of spread spectrum packet radio will be utilized. Network control must be distributed to avoid single points of failure and the system should be self-organizing with peer to peer capability. Adaptivity should be considered at all levels to optimize performance. Relevant areas of research include, but are not limited to, formal methods for protocol and network modelling, intelligent protocols, formal models of protocol performance and conformance, protocol conversion for tactical gateways, and adaptive protocols. Survivability in an electronic/ information warfare environment is a requirement.

E. Information Processing and Fusion and Circuits (Dr. William Sander)

Image Analysis and Processing

The understanding of image background, including target-competitive clutter, and of how image background compounds the difficulty of target detection and recognition is of paramount importance. The available models for background and clutter are currently inadequate. Objective measures of clutter and modeling paradigms that enable the quantification of image properties are needed for effective comparison of scenes, evaluation of algorithm performance, validation of synthetic imagery, and strategies for data fusion. Research is needed which addresses: (1) modeling of background and clutter, (2) definition and assessment of clutter metrics, (3) the manner in which clutter degrades the discrimination processes, and (4) interaction between image background and targets.

The three dimensional (3-D) to 2-D projection process causes object recognition from images to be an ill-posed problem. The detection, recognition, and identification of an obscured, concealed, or partially occluded object in an image of a scene cluttered with other target-like objects is a difficult and challenging task. The problem may be aided by the knowledge of the context, the nature of the ambient conditions (weather, terrain, clutter environment), and other relevant parameters. Algorithms for detection and classification of targets with small numbers of pixels in images with substantial background clutter, such as in Forward-Looking Infrared (FLIR) images are important. Algorithms to examine images with objects which have motion and can be observed over a number of sequential image frames is appropriate.

Research is needed which addresses: (1) the object recognition issues in general, (2) how the use of *a priori* and emerging knowledge and alternative data representations may contribute to the solution of the recognition problem, and (3) how the performance of the resulting algorithm/system may be evaluated

The development of algorithms for Automatic Target Recognition (ATR) must address highly variable target signatures in highly variable scenes and a variety of sensor types, both imaging and non-imaging. Simulation is the only economical and practical means for providing large amounts of data for parametric studies upon which the underlying theoretical foundation of ATR depends. There is a need to develop methods and metrics for validating the accuracy of simulated data. Simulation produces images which may be realistic to the eye but contain artifacts that could cause difficulty for algorithms. The methods and metrics must detect and represent these differences. In particular, performance quantification on synthetically generated data lacks creditability without a "validation data set" within every group of environments. Environments consist of meteorological states, target operational states, and target distortion ranges. Metrics to quantify data states and ranges for synthetic data calibrated using real data are needed to create "validation data sets" to enhance the credibility of test results.

Currently, there are no effective methods for predicting the performance of an Image Analysis and Processing system, given the input signal or parameters of the scene such as time of day or nature of clutter. There is a need to both understand the sensor and to represent the information content in the signal and how it affects the algorithm performance. As part of this effort, it is necessary to develop metrics that predict theoretical performance bounds and estimate how close the actual performance is to the predicted and optimal performance. Methods for characterizing the complexity of data/signals are required so that performance metrics can be used to compare different algorithms across different data sets.

There is a need for development of fast ways to perform such computations, especially for applications which demand closed loop execution, such as missile guidance. If fast implementations of such algorithms require special purpose computing architectures, then such architectures may be considered a component of the research. However, it is preferred that algorithms be developed for architectures that can be upgraded or improved at least every 18 months. The challenge for the future is to implement a modular, cost effective, embedded signal processor that is "incrementally" upgradeable and not anchored to a particular vendor or processing element, and that can be optimally configured for specific applications and algorithms.

There are multiple sources of data being transmitted for many diverse uses, e.g., ATR, mine detection, telemedicine, telemaintenance, visual display, cueing, etc. The coordination of the source coding compression methodology used and the application requirements are paramount. Compression methodology must be matched to data characteristics and application needs. There is a need to develop compression approaches that fulfill the multiuse requirements.

Model-based target detection, classification, recognition, and identification relies on databases consisting of models of target signatures, clutter signatures, etc. In real-world mobile scenarios, algorithms have to take into account thousands of potential target types, many of which are poorly characterized due to lack of training data, some of which may even be previously unknown. Algorithms also have to deal with continuously changing clutter and/or occlusion characteristics. The databases necessary to support model-based target identification are unlikely to be small enough, or well-characterized enough, to support real-time mobile applications. Some means of constructing and refining models "on the fly" from the input data stream is required. A sound theoretical basis is needed for such "agile" or "adaptive" modeling. For example, just as a conventional nonlinear filter is capable of extracting a low-observable target from the background and recursively refining an estimate of its state thereafter, so the desired "modeling filter" would initiate and recursively refine an estimate of the model of each target type (and perhaps also of clutter/occlusion processes) as they are encountered in a continuously evolving scenario. This research enables more efficient utilization of model databases and dynamic environments for the purpose of multisource, multitarget, detection, classification, recognition, and identification.

Information and Data Fusion

Multisensor and multidimensional data acquisition systems are becoming increasingly prevalent with sensing platforms remotely distributed on the battlefield. Processes such as target detection, classification, recognition, identification, and tracking often require fusion of information, much of which takes increasingly diverse forms and which is increasingly supplied by remotely distributed sources. To date, approaches to this general fusion problem have been addressed in heuristic, piecemeal, and disjoint fashion. Rigorous and heuristic approaches which have been used in this process include classical or Bayesian statistics, Dempster-Shafer, fuzzy logic, rule-based inference, plausible reasoning, rough set theory, and statistical capacity theory. A variety of information-quality measures are associated with these approaches: likelihood, possibility, belief, entropy, etc. Further progress in data fusion requires that the following four aspects of the fusion problem be addressed in a more systematic, unified, and theoretically sound fashion: (1) data representation, (2) data encoding and transmission, (3) pooling of diverse data into a coherent picture, and (4) measurement of the informativeness of both data and the fusion system. Ideally, a systematic, tractable framework is needed that will allow diverse input data streams to be transformed into a unified information fusion space for processing using more unified and tractable procedures, and which will permit performance to be measured with greater confidence. This framework must be open (i.e., permit growth in an emergent or epistemological process) and should provide systematic, tractable measures of information quality.

First, much information is corrupted by forms of ambiguity more extreme than those addressed by conventional statistical analysis: imprecision, vagueness, indiscernability, partial contingency, etc. Image data, in particular, presents unique difficulties. It is important that information from sources such as images, signals, voice messages, geographical information, natural language text, features and attributes, and rules from knowledge bases be presented/modeled in a unified framework (especially multidimensional data representations that are scalable in spatial and temporal resolution). For heterogeneous image and video data, it is known that scalable data representations offer advantages for fusion processes.

Second, current data fusion systems separate the problem of data transmission (from sensors to fusion processing) from the information needs of the fusion algorithms or human end-users. Since much of this data is accessible only via a communication network, fusion systems require variable amounts of data compression depending on such factors as congestion, mission, target priority, algorithm needs, end-user requirements, etc. (facilitated by a scalable data representation).

Third, mathematical methods for representing and fusing information from multiple sensors are fundamental (especially multidimensional data representations that are scalable in spatial and temporal resolution). Effective means are required to fuse diverse information originating from many sources into a single composite picture. A common example is track-to-track fusion, in which existing and possibly correlated or conflicting estimates/ decisions must be fused into a valid composite picture. Another example is that of fusing the (possibly correlated) decisions and/or estimates provided by a number of experts or fusion sources, each employing different evaluation criteria and using possibly overlapping data sources.

Fourth, a mathematical framework is essential for tractable means of measuring information content in diverse and ambiguous data. Evaluation of fusion system performance requires techniques capable of representing preferences, expert credibilities, weights of criteria importance, and data dependences in qualitative terms that lead to an aggregated choice of alternatives which are preferable or admissible but not necessarily optimal. Such measures should enable prediction of the level of system performance based upon the information content of sources available, knowledge gained from previous experience, tasks to be performed, and constraints in the context of the task to be performed.

Threat assessment is the process of estimating the current threat status of a target. Battle Damage Assessment (BDA) refers to determining the threat status of a target after an attempt has been made to destroy or disable it. Issues which require further research include: more systematic approaches to threat assessment and BDA which permit effective post attack evaluation. A common methodology should be developed that would support the optimal determination of current threat state based on reports gathered from multiple information collection resources.

Information and Signal Processing

Information and signal processing research is oriented primarily toward communication, image analysis for surveillance and target acquisition and information fusion. Multi-dimensional and concurrent signal processing as well as adaptive processing and array processing for null and beam steering adaptive antennas, direction of arrival estimation, and diversity combining are included. Also of interest are research topics in image, radar, and other sensor processing related to detection, identification, and tracking of targets in real time. An interest exists in high performance multi-dimensional and concurrent signal processing architectures. Architectures suited to classes of algorithms in automated targeting; information (sensor) fusion; antenna array processing for communications, radar, direction finding, emitter location, signal intercept, electronic countermeasures (ECM), electronic counter-countermeasures (ECCM), and electronic warfare (EW); data compression to reduce bandwidth; coding, decoding, and modulation for communications; and guidance and control are needed. Also of interest are novel and hybrid implementations such as neural networks, discrete event dynamical systems, or non-linear systems using electronic, biological, optical, acoustical, electro-optical, or acousto-optical techniques. Important aspects of this research include the development of design methods, architectures, and implementations to minimize power dissipation, to increase processing speed and concurrency, and to increase modularity for incremental upgrades.

Circuits

There is a need for original research on novel circuit designs which utilize new integrated circuit, acoustic wave, and/or photonic technologies to improve operating performance. Improvements are sought in performance parameters such as reduced noise, reduced power dissipation, and increased speed. Extending the bandwidth, time-bandwidth product, and upper frequency limits of circuits is included. Design tools for integrating RF devices and components, such as inductors and optics, on chip are needed to reduce size, weight, power, and cost. Circuits such as mixers, oscillators, amplifiers, phase-locked loops, voltage-controlled oscillators, digital-to-analog and analog-to-digital converters, correlators, and convolvers may benefit from this research. Typical goals may be to develop technology for implementing monolithic transceivers on single integrated circuits and processors capable of gigahertz operation.

F. Minimum Energy/Low Power Electronics (Dr. James Harvey, and Dr. Dwight Woolard)

The future Army communications, information processing, imaging, and other systems must be portable, functional, versatile, and highly reliable. In addition, the systems will require ultra-high speed capability for handling complex voice, data, and video multimedia signal formats. Many of the new systems will find application in wireless communications, infrared imaging, and portable diagnostic and computational equipment. As these systems become more sophisticated, the necessary electronic circuitry becomes more complex, with increased prime power requirements.

Currently, and in the near future, prime power for mobile and light weight system utilization is limited. It is necessary, therefore, to develop a new generation of electronic and other systems that can operate under minimum energy constraints with very low direct current (DC) power dissipation. This research topic goes beyond the simple desirability of efficient devices and circuits. It is aimed at new concepts resulting from considering the multilevel problem; materials, devices, circuits, coding, networking, and overarching system of systems considerations, in order to reduce overall power dissipation in RF systems. Research can be approached from the component level or the overall design level.

Fundamental research directed towards developing an understanding of the minimum energy required to provide functions such as communications will provide a basis for advanced system development. This involves determining the minimum energy that can be detected and the corresponding minimum energy required to be generated. Such analyses should include background noise, transmission losses, multipath, atmospheric attenuation, etc. Both theoretical and experimental projects are of interest. The systems will include both low DC power consumption digital and RF circuits. The digital portion of the unit would operate at low bias voltage to significantly reduce power dissipation. The RF transmit/receive portion of the communications system dissipates a significant fraction of the total power. Due to limitations imposed by the transmission requirements a finite level of RF energy must be transmitted. Therefore, it is necessary to develop a new generation of high-efficiency, low loss systems that can operate under minimum energy limitations.

Research on advanced modulation and coding techniques and associated circuit architectures that result in high integrity signals under reduced energy consumption conditions will provide the Army with the concepts necessary to realize next generation systems. Analyses that examine the tradeoffs between time domain and frequency domain techniques are of interest. Novel modulation techniques that will permit oscillators and power amplifiers to be operated under maximized high power-added efficiency conditions while maintaining linear performance need to be developed. It is anticipated that digital techniques will be widely utilized to make more effective use of available bandwidth, while maintaining high performance operation.

Novel semiconductor devices that can operate with high performance at low power dissipation will provide the building blocks to realize the new systems. Both digital and RF devices will be required. However, the Army has particular interest in RF devices for transmitters and receivers. System operation will extend from the low microwave bands to the millimeter wave region, depending upon the particular system application. Mixed mode circuits that utilize both digital and RF devices in novel architectures that permit functions to be implemented with minimized device counts and reduced energy consumption are attractive. Simple voltage scaling, while appropriate for complementary metal oxide semiconductor (CMOS) devices, may not be optimum for low power RF devices. Research that clarifies this issue is of interest.

Passive components such as filters, antennas, mixers, couplers, etc. are necessary building blocks for an electronic system. Research directed towards implementing these circuit functions in novel formats that are suitable for use in advanced integrated circuits will permit maximized integration to be achieved. Directed beam, phased array, and adaptive antennas are of particular interest since they permit high gain to be obtained. Advanced filters with narrow bandwidth and high off-band rejection and that can be implemented in small size suitable for use in integrated circuits are desirable.

Advanced models and simulation tools that can accurately predict device, circuit, and system performance need to be developed. The Army has interest in physically-based models that allow DC and RF performance to be determined as a function of material, device design, bias, RF circuit, and operating parameters. It will be necessary to include large-signal, thermal, and breakdown effects. Simulators that include statistical design capability and yield determination will find use in reducing manufacturing costs. Advanced models for directed beam antennas, filters, mixers, etc. are also of interest.

G. Electromagnetics (Dr. James Harvey)

Three drivers of Army interest in the fields of EM and millimeter wave/microwave circuit integration are the unique capabilities available for Army electronic systems operating at mm-wave frequencies and higher on the digitized battlefield of the 21st century, the need for innovative component and circuit advances for personal and mobile communications systems, and the need for exceptional capabilities for tactical antennas at lower RF frequencies. Novel systems capabilities can result from the unique propagation characteristics of the millimeter-wave frequencies, their imaging resolution, the potential system size reduction, and their large bandwidth. At lower frequencies, personal and mobile communications systems have requirements for small, lightweight, low cost, high performance, highly reliable circuits and components for military peculiar applications. Tactical antennas are needed which are capable of supporting multifunctional military communications systems and special purpose military applications. Research is sought in the following general technical areas: (1) innovative RF circuit integration, (2) EM modeling, (3) propagation over complex terrain, (4) mobile antenna research, and (5) mine detection.

Integration technologies provide millimeter-wave/microwave circuits at small size, light weight, low cost, and high reliability. Novel techniques for integrating circuits are of special interest at higher frequencies, in the millimeter-wave regime, in order to overcome loss, coupling, and spurious radiation problems. Hybrid techniques which combine high performance from component optimization with low fabrication cost due to compatibility with high volume production processes are needed at millimeter-wave frequencies and at mobile communications net wave frequencies. Higher levels of integration into chips, modules, and packages present special problems at higher RF frequencies. Dense integration techniques, including 3-D integration, must be developed. Thermal effects must be analyzed and minimized. Innovative approaches such as micromachining can provide significant advantages for circuit integration and the production and integration of passive components. Efficient power and signal combining techniques for RF frequencies, such as quasi-optical combining schemes, are needed. Innovative approaches to millimeter wave antennas are needed to develop antennas and antenna arrays with low losses and high efficiency. At millimeter wave frequencies antennas and antenna arrays tend to become part of the integrated circuit. Active antennas can increase functionality, compactness, and efficiency, and can introduce nonlinearity in the antenna for new applications such as phase conjugation. Special applications, such as conformal arrays for mounting on vehicle surfaces, can place physical limitations on size and shape. Some applications require very broadband or multiband operation. Adaptive antennas require the ability to switch in space and spectrum.

Electromagnetic analysis, simulation, and modeling are performed for several reasons. Quantitative answers can be obtained for a specific physical problem or circuit configuration, yielding qualitative understanding of a class of problems. The analysis is needed to guide experimental research and to place experimental results in perspective. Systems development decisions are guided by EM analysis of circuits, systems, packages, antennas, and propagation effects. Detailed analysis or modeling is used to design specific systems applications and it supports the optimization processes for Computer Aided Design (CAD) techniques. Of special interest is the simulation of integrated circuits and modules as the levels of integration become higher and higher, as the circuits become more dense and more complex, and as new circuit types such as leaky wave, quasi-optical, and active antennas must be addressed. The coupling of radiation into and out of complex structures is a problem of special interest. New analysis concepts, techniques, and methodologies are needed for increasingly complex systems. Innovative signal processing techniques are needed for ultra-wideband radar and ground penetrating radar.

Propagation effects have a major impact on communications and radar systems. Propagation loss and multipath effects such as path delay and fading can have a serious frequency-dependent effect on communication channels. These propagation effects become highly complex in urban and built up terrain or in terrain with heavy foliage. Propagation and scattering effects are also very important for radar systems, particularly for the detection of targets in clutter.

Innovative approaches to increasing the performance and decreasing the size and signature of tactical antennas operating in the HF, VHF, UHF, and microwave frequency bands are needed. Designs for multifrequency, multiband operation are of interest. Broad impedance bandwidths and pattern bandwidths are required for spread spectrum systems. Fast frequency switching over a wide band of frequencies is required for frequency hopping systems. Efficient coupling of EM energy into the ground is required for ground penetration radar antennas. Novel ideas for ultra-wideband radar are needed for enhanced performance.

Innovative electromagnetic and hybrid approaches are needed for the detection of mines and buried ordinance, with reduced false alarm rates. Radar, acoustic electromagnetic induction, gravitometers, and infrared techniques have been applied in traditional approaches. Innovations on the traditional approaches and hybrid combinations with potential improvements in performance and reduction in false alarm rate are of interest to this program.

ENGINEERING SCIENCES

I. INTRODUCTION

II. RESEARCH AREAS

A. Fluid Dynamics

B. Solid Mechanics

C. Structures and Dynamics

D. Combustion and Propulsion Sciences

ENGINEERING SCIENCES

I. INTRODUCTION

Research supported in the Engineering Sciences Division is concerned with a broad spectrum of fundamental investigations in the disciplines of fluid dynamics, solid mechanics, structures and dynamics, and combustion and propulsion. Though many creative and imaginative studies concentrate on a particular subdiscipline, increasingly, new contributions arise from interdisciplinary approaches such as the coupling between aerodynamics and structures, combustion and fluid dynamics, or solid mechanics and structures as in the structural reliability areas. Additionally, several common themes run through much of these four subdisciplines, for example, active controls and computational mechanics. Research in such areas is addressed within the context of the application rather than as a separate subject of study. Fluid dynamics research is primarily concerned with investigations in the areas of vortex-dominated flows, unsteady aerodynamics, and the thermal science of micro/meso-scale devices. Solid mechanics include a wide array of research areas such as high strain rate phenomena, penetration mechanics, heterogeneous material behavior, and reliability of structures. The structures and dynamics area is focussed on investigations in vehicle structural dynamics and simulation and air vehicle dynamics including rotor aeromechanics. Research in the combustion and propulsion sciences area is concentrated on processes characteristic of reciprocating (diesel) and gas turbine engines and gun propulsion and energetic material hazards. The following narratives describe the details of the scope and emphasis in each of these subdisciplinary areas.

II. RESEARCH AREAS

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

A. Fluid Dynamics (Dr. Thomas Doligalski)

Research in fluid dynamics supports the development of improved or new technology for advanced helicopters, small gas turbine engines, improved airdrop (parachute) systems, maneuverable high-speed missiles and high performance gun-launched projectiles. While basic research studies that address the fundamental flow physics underlying these devices are solicited, innovative research in the specific topical thrust areas listed below is especially encouraged.

Vortex-Dominated Flows

In contrast to fixed-wing aircraft, rotorcraft always operate under the influence of their own wakes. The prediction of rotor performance, vibratory loads, and blade-vortex interaction noise depends strongly on the accurate prediction of the rotor wake, and the prediction methodology of this wake remains one of the major challenges in fluid mechanics. Current computational fluid dynamics (CFD) approaches are computationally intensive, especially for Eulerian methodologies where the vorticity diffuses numerically through the grid points and makes predication inaccurate. The process by which vorticity is shed by the blade and rolls up to form vortex filaments is not now adequately simulated for rotorcraft load distributions. In fact, under certain flight conditions, multiple vortices are observed to form due to negative lift over the blade tip. The application of non-intrusive optical diagnostic techniques should yield new phenomenological understanding for the study of multiple vortices, wake structures, and wake development. New numerical algorithms or different techniques to increase accuracy and reduce the computational requirements are required.

Unsteady Aerodynamics

The flowfield around many modern Army weapons systems can be characterized by a high level of unsteady flow, which cannot be adequately predicted by steady or quasi-steady approaches. One classical example of very high Army relevance occurs on the retreating blade of a helicopter rotor, where the high angles of attack experienced by the retreating blade of the helicopter rotor lead to boundary-layer separation followed by load and pitching-moment overshoots. Mild separation causes increased vibration and reduces performance, while severe dynamic stall leads to unacceptably large vibratory loads and limits forward flight speeds, load, and maneuver capabilities. The physics of this flow phenomenon are known to depend on the Mach and Reynolds numbers of the flow, and hence future research in this area needs to be performed under realistic flight conditions. Improved theoretical and numerical simulation is needed for understanding the unsteady separation process and evaluating concepts for separation control. The simulations must be capable of accounting for transition of the boundary layer (and under some circumstances, the transition in the separating free shear layer). Detailed experimental measurements of velocity and pressure are needed in the separating region for understanding the separation process and validation of the numerical simulations. New non-intrusive optical methods may be appropriate experimental techniques. Combined experimental and numerical efforts towards control of unsteady separation using passive and active flow control (including the emerging field of Micro-adaptive Flow Control) are also sought.

A second example of the importance of unsteady aerodynamics occurs on maneuvering missiles and projectiles. As future emphasis in flight vehicle control and "smart" systems pervades munitions design, advances in aerodynamic phenomena, such as dynamic high alpha separation, vortex shedding, control surface/vortex interaction, divert thruster/vehicle interaction, roll control stability, and propulsion system integration will be required. New composite material vehicles will have stringent thermodynamic limits and enhanced nonlinear aeroelastic response to maneuver forces. Smart structures and MEMS technology will redefine control strategies, control surface shape and control surface dynamics, consequently driving fluid dynamics into new areas of research. All of these developments require the prediction and experimental verification of complex nonlinear transient flowfields. This will require improved CFD for turbulent flow separation prediction, large eddy simulation, vehicle vortex interactions, and accurate computations of gross flowfield response to MEMS boundary-layer flow perturbations. Parallel developments in experimental techniques will be required to measure these complex flowfields to help verify and guide the predictive technology.

Thermal Science of Micro/Meso-Scale Devices

Over the last decade the same microfabrication techniques originally developed for the production of electronic integrated circuits have been used to develop miniature mechanical devices (known as Micro Electrical Mechanical Systems, or MEMS). In fluid dynamics applications, the small size and mass of these devices have enabled the production of sensors and actuators with outstanding temporal and spatial bandwidth, enabling multiple applications for micro-flow control. Here the philosophy is the insertion of very small control forces at crucial spatial and temporal locations in order to obtain significant changes in system performance. The application of this micro-flow control technology to Army systems offers the promise of significant performance enhancement at reasonable life-cycle cost.

More recently, the sophistication of these microfabrication technologies has improved to the point where entire miniature machines can be developed. These miniature machines have a wide range of applications that have high relevance to the Army and specific application to the dismounted soldier. Examples include the development of micro-turbine power generators, air and water purifiers, compact cooling systems, and miniature unmanned aerial vehicles. The physics of these miniature devices can be significantly different than their macro-scale counterparts due to the very small scales involved, the two-dimensional nature of microfabricated flow channels, and the limitations imposed by the materials used by these fabrication techniques. Thus, research is needed in the areas of thermodynamics, heat transfer, and fluid dynamics of these miniature devices, as well as the multidisciplinary integration of these thermal science disciplines with chemistry, structural dynamics, and materials sciences, which enable the analysis of these devices.

B. Solid Mechanics (Dr. Kailasam R. Iyer)

The light, lethal, survivable, continental United States (CONUS)-based modern Army with quick power projection capabilities around the globe has abiding interest in building fixed and mobile assets in the most efficient manner with advanced materials. Weapons, platforms, ammunition, and ground structures are designed with severe weight and volume restrictions. Innovative use of material(s) combinations for specific applications necessitates understanding of the behavior of materials and structures under complex and severe constraints. Solid mechanics provides the link between optimized material properties on the one hand and the desired structural behavior in terms of changes in shapes under specific set of constraints on the other. Complete understanding of the behavior of structures made of advanced materials and quantitative description of their behavior allow predictive capability so necessary for design methodology. In situations that are described as ballistic in nature, the Army faces unique constraints of very high strain rates, large deformations, high pressures, and rapid changes in temperature. Analytical, experimental, and computational techniques are integrated to solve well-formulated problems. Predictive models, validated by well-characterized experiments, are needed to identify controlling parameters at every scale. These models must be implementable in codes for the analysis of the efficiency of the designed hardware in the performance of military missions. Though imaginative and promising research investigations in all these general areas are of interest, innovative research studies in the following specific topical areas are especially encouraged.

High Strain Rate Phenomena

In its many missions, Army hardware is subjected to overwhelming explosive force characterized by shock, high velocity deformation, damage, and failure. Computer codes are developed to model and visualize in three dimensions the performance characteristics of systems for optimization before decisions are made. Study of structural behavior under severe conditions will be facilitated by innovative computational methodologies. The purpose is to understand and model the deformation and fracture of materials under severe loading conditions. This includes high strain rates (up to 10^7 s^{-1}), large strains (up to 500%), high temperatures (up to melting), and high pressures (up to 5 GPa). Constitutive models should be three-dimensional (3D) and should allow for path dependency. Models of behavior of ductile and brittle solids that lead seamlessly from the elastic to the inelastic regime and on to material failure are sought. These models should be based on extant databases as well as new uniquely defined experiments. The primary application of these models will be for high velocity impact and explosive detonation computations. Models are required for a wide variety of materials including metals, ceramics, composites, and energetic materials. The models should be physically based and be suitable for incorporation into Lagrangian and Eulerian codes. An important aspect of this area of research is the development of innovative experimental techniques that can be used to generate data for the wide ranges and combinations of strain rates, strains, temperatures, and pressures of interest. To the maximum extent possible, these experiments should provide for direct measurement of stresses and other parameters. These new experimental techniques, together with data from existing experimental techniques, should be used to obtain constants for the models and to demonstrate and validate the models. The models should also be validated by computationally simulating tests that are more complex (such as cylinder impact, penetration and/or explosive-metal interaction).

Penetration Mechanics

Penetration mechanics is a research topic that integrates fundamental work in finite deformation, high pressure/high rate response, damage and failure mechanics, and computational solid mechanics. The mechanics and modeling of interfaces, in particular, need better understanding through innovative experimental and theoretical research. High velocity sliding, such as might occur at penetrator/target interface, must be understood on a physical basis. Computational methods for treating discontinuities in a 3D context are required. These methods must concentrate not only on the computational techniques required to track a moving boundary, but also on the relevant physics and mechanics associated with those surfaces. Examples might include boundaries between dissimilar materials, shock fronts, elastic/plastic boundaries, phase boundaries, shear bands and cracks, as well as penetrator/target interfaces. Penetration into brittle materials presents special challenges due to cracking and comminution of material ahead of the penetrator, high-speed granular flow of comminuted material, and the mixing of eroded penetrator material and comminuted target material. Ceramics and geologic materials exhibit extreme sensitivity to loading histories, which may manifest in apparent rate dependence of failure strengths and the propagation of failure waves. All of this requires greatly improved understanding, effective modeling, and efficient computational schemes. Penetration into composite materials presents still another set of challenges. Careful experimental techniques are required to delineate the nature, timing, and evolution of damage and failure in composite targets. Analytical models at multiple scales validated by carefully designed experiments are needed. Future ultra-lightweight armors will involve a combination of layered and graded structures that are highly anisotropic and heterogeneous. Linearized homogeneous isotropic conventional theories will not be adequate to describe the shock and penetration response of such material combinations. Since the complex interactions between the shock and release waves usually initiate the damage mechanisms in the target, accurate modeling of the target behavior will require controlled, interrupted experiments. Novel concepts are essential to defeat the projectile upon impact. Improved understanding of projectile and target interaction will require innovative diagnostic experiments and predictive modeling capabilities. Since penetration involves erosion and sliding of both the projectile and the target, explicit modeling of these processes with friction-based theories and computational techniques are essential. Innovative research of processes and phenomena in materials and structures which can be triggered by impact to absorb energy, deflect penetrators, and/or laterally disperse momentum is encouraged.

Reliability of Structures

Technologies that enhance fundamental understanding of damage initiation and progression, failure mechanisms, and life prediction are important thrusts in the reliability of structures. The mechanics of heterogeneous structures involves the development of integrated analytical, computational, and experimental approaches to investigate the response of hybrid structures that may include combinations of high strength and lightweight engineered composites, ceramics, and functionally graded materials. Physically-based structural design guidelines for energy absorbing structural systems comprised of tailored combinations of materials and heterogeneities at different length and time scales are sought. There are continuing technology barriers that need to be overcome if reliable Army structures such as helicopters, ground vehicles, bridges, and weapons systems are to be designed, manufactured, and maintained over a long period of time. Of special interest to the Army is the thermo-mechanical response at strain rates encountered in high-speed impact or explosive loading. Probabilistic as well as deterministic approaches are encouraged. Phenomena of interest are wave propagation, scattering, dispersion, damage evolution, and failure.

Quantitative prediction and measurement of critical length and time scales and dominant heterogeneities and mechanisms for specific material systems are needed to relate nano and micro effects to the macro scale. Deterministic and statistical scaling methodologies for toughness, strength, and geometrical effects that account for the multitude and variabilities of heterogeneities such as interfaces, interphases, particulate dispersion, fiber volume fraction and distribution, constituent shape, and their combined effects on failure are needed. Innovative methods and models to control material properties and damage by graded interfaces, coatings, and mechanical impedance mismatches are required. Computational models for the creation of free surfaces that are mesh independent and that incorporate evolving time-dependent boundary conditions and physically-based failure initiation criteria need to be developed. Experiments have to be designed to delineate the effects of failure initiation, interaction, and rupture. Necessary and sufficient conditions are needed to determine when to follow failure from initiation to rupture. Constitutive relations for these multi-scale mechanisms should include failure and damage criteria, which are mechanism-based and experimentally verifiable.

The application of modern theories of critical phenomena to solid mechanics remains largely unexplained. The determination of universal scaling laws would greatly enhance our understanding of phenomena such as inelastic deformations, localization, distributed damage and failure, fragmentation, etc., and engineering parameters such as projectile residual velocity near the ballistic limit. Advances and approaches based on analyses of diverse data sets or of physically representative model problems of specific phenomena are needed for scaling laws corresponding to an underlying physical universality.

C. Structures and Dynamics (Dr. Gary Anderson)

A significant challenge facing Army laboratory engineers is the determination of the influence of inertial, thermal. electrical, magnetic, impact, damping, and aerodynamic forces on the dynamic response of adaptive armament systems, ground vehicles, rotorcraft, missiles, projectiles, gears, parachutes, and shelters. Its resolution is of fundamental importance to the design and construction of affordable, reliable, durable, and maintainable Army equipment with acceptable levels of personnel safety and comfort. Consequently, the US Army Research Office is supporting basic research in these areas, with emphasis on rotorcraft dynamics; the dynamics, structural control, and simulation of ground vehicles and weapon systems; and the dynamic response of structural components and systems fabricated from advanced composite materials, with or without embedded actuators and sensors. While the consideration of Army relevant, fundamental research proposals on these general topics is encouraged, more specific details of the program's predominant thrust areas are described in the following paragraphs.

Structural Dynamics and Simulation

This topic consists of six thrusts: smart structures, structural dynamics, structural damping, active structural control, structural health monitoring, and inflatable structures. Advances in these areas are required to improve capabilities of modeling, computing the dynamic response, reducing noise levels, suppressing vibrations, detecting the presence of damage, and assuring the integrity and performance of structural components used in military systems.

Adaptive structures are currently being considered for application in helicopter rotor systems, missiles, projectiles, electromagnetic antenna structures, and weapon systems. They offer opportunities to realize structural vibration suppression or isolation in rotorcraft and weapon systems, unsteady load control on rotor blades, reduction of blade/vortex interaction noise, airfoil shape change, gust load alleviation, aeromechanical stability augmentation, beam shaping and steering in antennas, and structural damage detection. Research areas include sensors and actuators, formulation of suitable constitutive relations, modeling and optimal design of smart composite structures, finite element formulations and control algorithms. New active damping techniques, based, for example, on combinations of viscoelastic and active materials, combined with shunted electric circuits and non-linear adaptive control strategies, have emerged as candidates for improving structural performance and reliability. Topics of interest include the role of viscoelastic materials, constitutive equations, elastomeric dampers for missiles and rotorcraft, magnetorheological fluid dampers, modeling and design, non-linear control techniques, and techniques for including damping effects in mathematical and computational models.

The trend toward the increasing use of composite materials in the fabrication of military vehicles to reduce weight and augment fuel efficiency requires that Army engineers have the tools necessary to predict the static and dynamic response of composite structures. During the course of service, virtually all composite structures should be monitored to assure their condition of health and integrity to prolong their life span or to prevent catastrophic failure. Recent developments in sensor and actuator technologies have opened the way to develop new diagnostic technologies particularly suitable for composite materials. Such enhancements might involve approaches such as wavelet transforms, neural networks, fuzzy logic, probabilistic estimations, system identification, electro-mechanical impedance methods, electric impedance tomography, etc. The development of the associated software will have to include the presence of distributed sensors, actuators, and controllers based on fiber optics, piezoelectric materials, MEMS devices, or other concepts.

Inflatable structures, such as large tent-like structures for ground/air vehicle maintenance shelters, have a variety of significant applications for Army operations and are advantageous due to their lightweight and transportability. A framework of inflated toroidal and cylindrical tubes acting like arches and beams supports these structures. A principal research requirement is to attain the understanding of the behavior of recently developed materials, such as 3-D woven or braided fabrics, and to determine how they can be effectively utilized in inflatable structures. Fundamental research is needed to establish theoretical models of inflatable structures as well as to develop procedures for accurate and efficient analyses and design.

Air Vehicle Dynamics

Rotorcraft aeromechanics analytical prediction capability must be improved to increase military effectiveness of rotorcraft through better mission performance, improved availability and dependability, and reduced life cycle costs. Advanced comprehensive analyses must address rotor blade control surface devices that use aerodynamic forces to excite structural response in order to minimize blade and fixed system vibratory loads and/or to improve the vehicle's aeroelastic stability characteristics. Of great importance in helicopter dynamics is the development of numerical analysis tools that are applicable to the special challenges associated with moderate to very large systems of equations (typically finite element based) that are needed to determine solutions for rotorcraft trim, periodic response, and transient behavior. The types of numerical analyses that are needed include: (1) the determination of the periodic solutions to the equations (both stable and unstable orbits) and of the unknown parameters that are associated with a specified flight condition, (2) traditional constant and periodic coefficient eigenanalysis of these system orbits and limit cycle or chaotic behavior of unstable orbits, and (3) determination of optimal design, optimal trim, and optimal control of such systems.

Smart structures concepts offer the Army the potential to address critical problems in helicopter systems including vehicle vibration suppression, control of rotor blade vibratory loads and fatigue stress, reduction of interior and exterior noise, gust load alleviation, enhancing rotor aerodynamic efficiency and performance, and augmenting aeroelastic/aeromechanical stability. These advances may be achieved by using smart structures approaches, for example, to twist the rotor blade along its length, to actuate a flap or elevon control surface at the blade trailing edge, or to change the airfoil camber or leading edge shape. The development of control algorithms is needed to tailor the inputs to multiple actuation sites, integrate information from multiple sensors, and optimize overall controller architecture including the development of appropriate data processing and software techniques.

The Army's requirement to deploy soldiers and equipment rapidly and safely dictates the use of parachute insertion usually at high speed and low altitude to minimize detection and exposure to enemy fire and maximize the drop accuracy. Parachute deployment and inflation is a challenging problem in aeroelasticity requiring multi-disciplinary modeling for coupling the structural deformations of the parachute material with the three-dimensional and highly unsteady aerodynamic environment. Prediction of a parachute system's response to user control and environmental factors once deployed also requires a coupled approach. For instance, an airdrop problem for which no three-dimensional coupled simulation capability currently exists is that of predicting the aerodynamic performance of fully deployed airdrop systems such as a steerable parafoil or a steerable round or cross canopy. Issues include: determination of (1) the lift to drag ratio of such systems, (2) the outcome of a control input, and (3) the system response to environmental inputs such as winds.

Weapon System and Land Vehicle Dynamics

The overarching goal of weapon system research is the improvement of firing accuracy. Improved weapon system accuracy reduces the number of rounds required to complete a mission; thus the ammunition logistics requirements of a unit are reduced. Vehicle generated disturbances (environmental or internal) and firing disturbances excite the structural dynamics between the sighting system and the weapon mount and the dynamics of the weapon itself. Innovative, unique, and far reaching research is required to explore fundamental issues in simultaneous control and structure design, ultra-high performance hybrid weapon drive systems, smart structures for vibration suppression and micro-positioning of gun barrels, high speed emplacement mechanisms and non-traditional barrel structures. Specific areas include mechanism theory and optimization, vibration, multi-body dynamics, smart materials, distributed servo control, software development tools for mechanical design and optimization.

Numerous large, complex mechanical systems used by the Army consist of interconnected multi-body structures, e.g., heavy machinery, wheeled/tracked military land vehicles, machine tools, rotorcraft, weapon systems, etc. These complicated systems often consist of numerous combinations of rigid and flexible elements. New and innovative approaches are needed for the efficient analysis, design, and control of large vehicles that consist of interconnected flexible bodies. Recent advances in computer and graphics hardware and software capabilities are stimulating recent advances in motion based simulators with computer generated imagery that interfaces vehicle dynamic models and their physical environments. Innovative approaches for modeling the deformation of vehicle system components based on the finite element method and experimental identification techniques are needed to develop more detailed models of complex vehicles. Examples of potential research areas are automatic formulation of the constrained equations of motion, symbolic equation processing, generation of computational methods and associated computer codes, algorithm optimization for computer architectures, model reduction and error quantification techniques, fluid payload dynamics, suspension systems and control, weapons positioning control, optimization techniques, and non-linear control algorithms.

D. Combustion and Propulsion Sciences (Dr. David Mann)

Combustion and propulsion research supports the Army's need for higher performance propulsion systems. These systems must also provide reduced logistics burden (lower fuel/propellant usage) and longer life than today's systems. Fundamental to this area are the extraction of stored, chemical energy and the conversion of that energy into useful work, for vehicle and projectile propulsion. In view of the high temperature and pressure environments encountered in these combustion systems, it is important to advance current understanding of fundamental processes as well as to advance the ability to make accurate, detailed measurements for the understanding of the dominant physical processes and the validation of predictive models. Thus, research in this area is characterized by a focus on high pressure, high temperature combustion processes and on the peculiarities of combustion behavior in systems of Army interest.

Engines

Research on combustion in engines is focussed on intermittent, reacting flows encountered in diesel combustion chambers and on continuous combustion characteristics of small, gas turbine combustors. Optimizing engine performance, through understanding and control of in-cylinder combustion dynamics, while retaining high power density, is a major objective. This focus leads to a strong emphasis on fuel injection processes, jet break-up, atomization and spray dynamics, ignition and subsequent heterogeneous flame propagation. Research on heterogeneous flames requires supporting study into kinetic and fluid dynamic models, turbulent flame structure, soot formation and destruction, flame extinction, surface reactions, multiphase heat transfer, and other factors which are critical to an understanding of engine performance and efficiency. An additional consideration is the high pressure/temperature environment, encountered in advanced engines, which influences liquid behavior and combustion processes at near-critical and super-critical conditions. Of particular interest are investigations of fundamental characteristics related to low heat rejection (adiabatic) type engines such as elevated temperature combustion, accelerated mixing, and transient heat transfer. Engine performance degradation under low temperature conditions, due to reduced fuel volatility, high oil viscosity, poor atomization and vaporization, etc., is a major concern. Fundamental research is needed in many areas, including low temperature physical and chemical rate processes, instantaneous friction and wear mechanisms, and combustion instability effects at low temperatures. With advances in sensing, modeling and control architectures, it is becoming possible to further optimize the performance of combustion systems. Providing the foundations for such active control is also a major goal of the program.

Propellant Combustion Processes

Research on propellant combustion processes is focussed on understanding the dynamics of the planned and inadvertent ignition and subsequent combustion of energetic materials used for propulsion in gun and missile systems and in ordinance. Basic research is needed in several areas, including, plasma- and laser-induced ignition; thermal pyrolysis of basic ingredients and solid propellants; flame spreading over unburned surfaces (particularly in narrow channels); surface reaction zone structure of burning propellants; chemical kinetics (including possible ion kinetics in the presence of plasmas) and burning mechanisms; propellant flame structures; characterization of physical and chemical properties of propellants and their pyrolysis products; and coupling effects among the ignition, combustion, and mechanical deformation/fracture processes with or without the presence of a plasma. The use of advanced combustion diagnostic techniques for flame structure characterization and determination of reaction mechanisms is highly encouraged. This includes characterization of radiative and convective stimuli delivered by plasma injection sources as well as the thermal, kinetic, and mechanical responses of the propellant. Complementary model development and numerical solution of these same ignition and combustion processes are also essential. There is also need to understand the unplanned or accidental ignition of energetic materials due to stimuli such as electrostatic discharge, impact, friction, etc. This requires, for example, research on the processes of energy absorption and energy partitioning in the materials, the effect of mechanical damage on the ignition events, and other topics relating to the safety of energetic materials.

ENVIRONMENTAL SCIENCES

I. INTRODUCTION

II. RESEARCH AREAS

A. Terrestrial Sciences

B. Atmospheric Sciences

ENVIRONMENTAL SCIENCES

I. INTRODUCTION

The Environmental Sciences program supports fundamental research in the Atmospheric and Terrestrial Sciences, *i.e.* research in the physical sciences of planet Earth in support of Army requirements. The need for research in the environmental sciences stems from the impact that the environment has upon virtually all aspects of Army activities. As military technology become ever more complex and sophisticated, both systems and operations are increasingly influenced by the natural environment and variability in environmental conditions. Despite continuing Army efforts to develop an all-weather/all-terrain capability, environmental conditions still constrain Army operations. Thus, the potential impact and leverage of environmental factors must be clearly understood in order to increase existing system capabilities and performance, take advantage of environmental weakness within adversary systems, and optimize the design of new systems. The ability of the Army to function properly and efficiently in all these environments requires equipment and tactics designed with full knowledge of the potential effects of the environment. Intelligent planning for the battlefield must take advantage of the environment. An in-depth understanding of individual environments on micro- to macro-scales and capabilities to predict environmental effects and behavior for places and times differing from the here and now are required. Advanced simulators for training and mission rehearsal require realistic behavior of atmospheric processes and terrain. Domains of specific interest range from the shallow subsurface, the land surface and the earth-air interface, to the lower atmosphere and cover surficial environments which vary from the polar regions to the tropics under all weather conditions, both favorable and adverse.

The Army is also committed to be a national leader in environmental and natural resource stewardship for the present and future generations as an integral part of its mission. Responsibilities in this arena include the restoration of sites contaminated through prior Army activities, as well as achieving a state of environmentally sustainable operations on all military installations, particularly those utilized for training and testing. Cost-effective land use and restoration requires in-depth knowledge and understanding of the physical principles and processes operating in the terrestrial and atmospheric domains across a variety of scales which range from the microscopic to megascopic.

The natural environment is, by nature, a multifaceted and dynamic system so that there is an increasing need for multidisciplinary approaches to address the complex research issues that presently characterize the atmospheric and terrestrial sciences. Because of limited resources, not all subjects that fall within the broad interest areas defined below can be included in the current ARO Environmental Sciences research program at any point in time. Emphasis areas are reviewed periodically and funding concentrated in specific areas on a 3-5 year time frame. The submission of informal pre-proposals (1-2 pages) of your research ideas is strongly encouraged. For Terrestrial Sciences funding consideration, pre-proposals should be submitted in November of each fiscal year. These pre-proposals will receive an evaluation in terms of technical relevance and merit. Offerors whose pre-proposals are evaluated as having significant technical relevance and merit will be requested to submit a complete proposal during the April-May time frame of each fiscal year.

II. RESEARCH AREAS

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

A. Terrestrial Sciences (Dr. Russell S. Harmon)

In general, the Terrestrial Sciences program is concerned with the impact of the earth's surficial environment on Army activities. Program interests cover a broad spectrum, ranging from terrain characterization and analysis, military engineering and mobility considerations under combat conditions, to the management and stewardship of its installations as regards the impact of Army activities on the natural environment. Primary emphasis is directed toward understanding the behavior of the land surface and the near-surface environments, understanding the natural processes operating upon and within these domains, and modeling these environments for predictive and simulation purposes. Special emphasis is given to the need to better understand, model/simulate, and predict those environments/conditions that are most extreme, dynamic, or restrictive to systems performance or military operations. The three areas of current interest to the Terrestrial Sciences program are elaborated in the following paragraphs. In all cases, the emphasis is on basic research.

Terrain Properties and Characterization

Terrain affects all aspects of Army operations. The effective understanding and use of terrain is critical to military success on the battlefield. It is in effect a force multiplier, affecting mission planning, system performance, unit mobility and effectiveness, and training readiness. At present, the Army cannot rapidly and efficiently perform the terrain analysis that is required before personnel, vehicles, and weapons are deployed. A 'rapid mapping' capability to remotely sense and interpret the features of and upon the earth's surface and an automated capability/ methodology for handling and analysis of large aggregates of remotely sensed data are critical for the 21st Century Army. Terrain information may be considered elevation data, soil and environmental characteristics, natural terrestrial features and man-made structures, and urban environments. Research related to terrain characterization is directed toward fostering the development of advanced geoscience capabilities for the rapid post-acquisition generation, analysis, and utilization of terrain data acquired through remote sensing technology. Characterizing terrain features and conditions from sparse data and the accurate detection and short-term dynamic surface conditions and terrain feature change are high priority research issues.

Terrestrial Processes and Landscape Dynamics

The effects of adverse terrain and environmental conditions can directly affect the Army's strategy, mobility, logistics, and field operations. A continuous dynamic interaction takes place between solid earth materials and the most abundant fluids, water and air. Fluvial processes are dominant in shaping the continental surface through both erosion and deposition, but in more arid regions, eolian processes can give rise to active depositional landforms. Military problems arising from these interactions include localized flooding in battle areas, deterioration of trafficability, and obscuration from blowing dust and sand. The nearshore zone is a complex boundary region where air, land, and sea interact over a wide range of space and time scales. At 0°C, water changes from the liquid to solid phase, which results in the formation of snow, ice and frozen ground, conditions that dramatically alter the battlefield environment and affect the performance of systems and materiel. Tropical and desert environments present particular challenges to Army personnel, materiel, and vehicles. An improved understanding of the fundamental character and dynamic nature of the surface environment and its evolution through time, as well as the consequences of military interaction with this environment, is essential for the continued development, improvement, and sustainability of Army operations and training activities. In particular, there is a need for the development of first-principle physical/chemical process models and computer-based techniques for monitoring, modeling, and simulating the natural environment, as well as improved technologies and methodologies for environmental characterization and prediction. Special emphasis is given to the need to better understand, model/simulate, and predict those environments/conditions that are most dynamic or restrictive to systems performance or military operations. Thus, improved understanding, physical representation, and quantification of terrestrial processes affecting Army operations are the focus of this research area. Improved measurements and theoretical treatments are needed to treat the complex, often nonlinear dynamics governing these processes, which are a result of both physical and biologic processes and the interaction of these processes with terrain evolution. Such processes operate over a wide range of discontinuous time and space scales, which make them extremely difficult to characterize, quantify, and model. Explicit consideration of these processes and their interactions will lead to critically needed improvements in the ability to predict environmental effects on Army operations. Important in this context is research that seeks the response of landscape to modification by Army use and the fundamental nature of subsurface flow and mass transport and then numerically model these complex processes. Critical to developing an engineering-scale understanding of the properties and behavior of surface environments is a fundamental knowledge about the natural processes that operate on surficial materials at a variety of scales. Field observation, laboratory experiments, and computational modeling must be integrated to solve well-formulated problems. Predictive geotechnical models, based upon well-characterized constitutive relationships, are required to identify controlling processes and parameters across a spectrum of scales.

Terrestrial System Modeling and Model Integration

The ultimate objective of much of the effort to characterize the natural environment and study surficial processes is to develop or enhance integrated system models and simulators. The Army maintains various modeling and simulation systems, such as the *SYNTHERM* cold climate energy balance model, *NATO Reference Mobility Model,* the *Engineer Obstacle Planning System,* the *Surface Water Modeling System,* the *Groundwater Modeling System,* the *Watershed Modeling System,* the *Army Training and Testing Area Carrying Capacity Model*, and the *Integrated Dynamic Landscape Analysis and Modeling System,* - plus the emerging *Land Management System,* to name but a few. These current systems allow computation of a variety of outputs, including mobility analyses, watershed response, groundwater flow and transport, military reservation land use response, and prediction of winter specific engineering effects. The Army is continually developing new features for existing numerical models and, in some instances, new environmental model systems. Research products, to be fully useful, must be integrated into modeling systems. This is often a non-trivial undertaking. The integration of the output from existing models offers many challenges related to different computational domains, resolution, and time scales. The ability to integrate advances in fundamental theory and process understanding is necessary to fully exploit these advances.

B. Atmospheric Sciences (Dr. Walter D. Bach, Jr.)

The Army has the responsibility to provide fundamental knowledge of the atmospheric boundary layer over land to all US armed services since that boundary layer is the primary theater for Army operations. Intelligence preparation of the battlefield depends on a full knowledge of atmospheric conditions and their effects on operations, weapon systems, and the soldier. It requires an ability to estimate atmospheric details at specific locations and a future time to maximize strategic weather advantages. Knowledge of the atmosphere and its effects on soldiers and sensor systems are essential for command and control as well as visualization of the battlefield at all echelons. The Army lead for chemical and biological defense requires detailed knowledge of the threat once it is induced into the air. In garrison, Army training and preparedness depend on accurate representation of atmospheric test conditions and on physically correct portrayal of atmospheric processes and effects in simulations.

The research program is broadly based to address the wide spectrum of conditions and influences of the atmospheric boundary layer on Army operations and systems. It is divided into three general research areas of the boundary layer problems: atmospheric effects on sensors and systems, characterization of the atmosphere at high resolution, and management of atmospheric information.

Atmospheric Effects on Sensors and Systems

The Army depends heavily on propagation of electromagnetic and acoustic signals through the atmosphere for detection, ranging and operation of smart munitions as well as reconnaissance and information dominance of the battlefield. The rapid detection, identification, and quantification of chemical and biological agents in addition to natural and induced aerosols remotely and in place, require understanding of the atmospheric effects on the sensors. Atmospheric turbulence can severely impact the performance of optical and infrared sensors as well as acoustic detection systems by affecting the propagation, imaging, and coherence of the received signals from active or passive systems. Furthermore the effects of surface and natural environmental conditions on propagation of images and signals must be considered because of the near-ground operation of many Army systems.

Characterization of the Atmosphere at High Resolution

Research efforts concentrate on increasing Army knowledge of physical processes in the atmospheric boundary layer at the engagement scale of the battlefield. This scale, characterized by horizontal distances to 20 km at resolutions at 10's of meters and times of seconds to hours, is the most inhomogeneous and changeable portion of the atmosphere.

The principal research concern is the diurnal evolution of the turbulent atmospheric boundary layer. Research topics span a full spectrum of atmospheric boundary layer dynamical conditions including, but not limited to: parameterization and scaling of boundary layer processes for microscale and mesoscale predictive models; surface conditions from simple to heterogeneous terrain elevation and slope, vegetation, and moisture; surface energy budgets; scale interactions; temperature and moisture fluctuations, especially as they affect the atmosphere as a medium for propagation of acoustic and electromagnetic signals; and natural or induced obstructions to visibility. A principal focus of the boundary layer dynamics is their application to prediction of the mean and fluctuating concentrations of chemical and biological agents in realistic terrains on appropriate scales.

Comprehensive measurements of wind velocity, temperature, moisture, surface energy exchanges and fluxes at resolutions showing their scales of variability in the atmospheric boundary layer are essential for advancing understanding of boundary layer processes affecting Army operations and systems. The variables should be measured in space and time to clearly define the evolution of three-dimensional physical processes within a volume of interest. Such measurement programs should highlight both the instrumentation development and the interpretation of the physical processes from the sensed data.

These topics are considered from perspectives of theory, field experiments, and analyses of the representativeness and validity of models and simulations of these processes. The research results are expected to contribute to improved models of boundary layer processes for visualization and field use through strong interactions with appropriate Army laboratory scientists.

Management of Atmospheric Information

Providing useful atmospheric effects information to the soldier and decision-maker is the focal point of the Army's atmospheric sciences effort. The information needs of each user may be very different. Furthermore, the information must be in a form that is readily understood in light of the user's needs. At the same time, the path from data to information must have a fundamental scientific basis. The science issues behind the information management include: an ability to obtain data from multiple sources, friendly or adverse, quantitative and qualitative; fusing the data into a comprehensive representation of the present and future atmospheric state; understanding of the uncertainties of the data and their effects on the application; and communicating the complex four dimensional atmospheric in the language and application of the user. To accomplish the goals of information management, improved computational methods are needed to assimilate and integrate the data, assess the atmospheric present and future state, and disseminate the user's needed information in a timely and effective manner.

MATERIALS SCIENCE

I. INTRODUCTION

II. RESEARCH AREAS

A. Degradation, Reactivity, and Protection of Materials

B. Mechanical Behavior of Materials

C. Synthesis and Processing of Materials

D. Physical Behavior of Materials

MATERIALS SCIENCE

I. INTRODUCTION

The objective of research supported by the Materials Science Division is to discover the fundamental relationships that link chemical composition, microstructure, and processing history with the resultant material properties and behavior. The work, although basic in nature, is focussed on developing new materials, material processes, and properties that promise to significantly improve the performance, increase the reliability, or reduce the cost of future Army systems. With the need for lighter weight and higher performance systems in the future, program emphasis has increasingly shifted away from metals research to a more balanced program with interests that cross a broad spectrum of materials, including polymers, ceramics and semiconductor materials. Fundamental research that lays the foundation for the design and manufacture of multicomponent systems such as composites, hierarchical materials and "smart materials" is of particular interest. Individual work units are organized into the research areas listed below.

II. RESEARCH AREAS

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

A. Degradation, Reactivity, and Protection of Materials (Dr. Robert R. Reeber)

The program in Degradation, Reactivity, and Protection of Materials investigates the metastable behavior of materials prepared by nonequilibrium surface processing approaches, including high pressure, shock, plasma, beam, and self-assembling techniques. The principal objective is to discover new non-equilibrium structural materials and novel smart materials, which will enhance the reliability of Army systems in service. This research includes non-destructive characterization of smart and ultrahard/superstrong materials and in-situ process monitoring. Principal emphasis is on surface or interface control during processing of these materials, characterization of their near-surface transport behavior and surface properties, and modeling or theoretical predictions of their properties. The synthesis of novel degradation-resistant, ultrahigh strength nanolaminates and other refractory materials is also of interest. Experimental and theoretical approaches are sought that provide for characterization of surfaces and interfaces, modification of surface and near-surface regions, and processing and materials characterization as this relates to the structure, wear, and environmental resistance of smart materials and ultrahard/superstrong structural materials. Other phenomena including spectroscopic and chemical analysis of low level hydrogen and hydrocarbons, where these are important for understanding the properties of such new materials during processing and in-service life assessment, are also of interest.

B. Mechanical Behavior of Materials (Dr. Wilbur C. Simmons)

The program on Mechanical Behavior of Materials addresses the fundamental relationships between the structure of materials and their mechanical properties as influenced by composition, processing, environment, stress state, and loading rate. The objectives of the subfield are to provide structural materials with improved mechanical properties and quantitative models for predicting both the response and the remaining useful life of a material. Major thrusts include the development of new strengthening, plasticity and toughening mechanisms for preventing or retarding fracture; especially at large strains (to 1000%) and high strain rates (to 10^6/sec). New knowledge is sought concerning fundamental deformation processes in materials including: load transfer, fatigue, creep, transformation toughening, superplasticity, and shear localization. New processing procedures are required for optimizing the mechanical properties of a material and reducing the inherent variations in the mechanical properties of materials. Additional thrusts include fundamental investigations on biomimetic and hierarchical materials to afford improved mechanical behavior and reliability. A fundamental understanding of the role of grain boundaries and interphases in composites and their hierarchical relationship to the overall mechanical behavior of the material system is desired.

C. Synthesis and Processing of Materials (Dr. Kathryn Logan)

The program on Synthesis and Processing of Materials focuses on the use of innovative approaches for processing high performance structural materials reliably and at lower costs. Emphasis is placed on the design and fabrication of new materials with specific microstructure, constitution, and properties. Research interests include experimental and theoretical modeling studies to understand the influence of fundamental parameters on phase formation, microstructural evolution, and the resulting properties, in order to predict and control materials structures at all scales ranging from atomic dimensions to macroscopic levels. Trends in this subfield include non-equilibrium materials processing (e.g., rapid solidification); powder synthesis and consolidation; novel processing of ceramics, polymers, metals and composites; welding and joining including composite materials; elastomers; fibers and fabrics; and utilization of microstructural, compositional, or other unique signatures which may provide non-destructive in situ feedback process control to enhance product reproducibility and quality. Supercritical fluid, shock-induced chemical processing and other innovative approaches for processing materials are also of interest.

D. Physical Behavior of Materials (Dr. John T. Prater)

The program of Physical Behavior of Materials seeks research directed at providing an improved understanding of the fundamental mechanisms and key materials and processing variables that determine the electronic, magnetic and optical (EMO) properties of materials and affect the reliability of EMO devices. Emphasis is on research that will facilitate the nanostructuring of materials to realize the materials-by-design concept where new and unique materials are constructed on the atomic scale with application-specific properties. This includes research on understanding the underlying thermodynamic and kinetic principles that control the evolution of microstructures; understanding the mechanisms whereby the microstructure affects the physical properties of materials; and developing insight and methodologies for the beneficial utilization and manipulation of defects and microstructure to improve material performance. Major trends in this subfield include: (1) electronic materials - materials for microelectronics and packaging; fabrication and processing of semiconductors, interconnects and device structures, and the characterization and control of trace impurities, defects and interfaces in semiconductors, (2) magnetic materials – bulk and thin-film processing of permanent magnets, soft magnets, and materials for high frequency applications; and fundamental studies on magnetic coercivity and spin dynamics, and (3) optical materials - materials and processing methods for detectors, lasers, nonlinear optical materials, refractive and diffractive optics, and optical windows and coatings. Research to improve the long-term stability of EMO materials, develop multifunctional or smart EMO materials, and develop low observable materials is also being sought.

Other important areas of interest include new approaches for materials processing, new composite formulations, and surface treatments that minimize environmental impacts; and novel composite concepts, including multifunctional and hierarchical materials. Finally, there is general interest in identifying basic research in the area of manufacturing science, which will address fundamental issues related to the reliability and costs (including environmental) associated with the production and long-term operation of Army systems. The foregoing areas of research are not intended to reflect all of the activities of the Materials Science Division. We are always interested in new ideas and cross-disciplinary concepts in materials science that may have future applications for the Army.

MATHEMATICAL AND COMPUTER SCIENCES

I. INTRODUCTION

II. RESEARCH AREAS

A. Applied Analysis

B. Computational Mathematics

C. Stochastic Analysis, Applied Probability, and Statistics

D. Systems and Control

E. Software and Knowledge-Based Systems

F. Discrete Mathematics and Computer Science

III. CURRENT PRIORITIES

MATHEMATICAL AND COMPUTER SCIENCES

I. INTRODUCTION

Mathematical and computational methods pervade research, development, testing, and evaluation problems encountered by the Army. Furthermore, increasing demands are being placed on research in the mathematical and computer sciences because of their fundamental role in the analysis and modeling issues that arise in military science, engineering and operations. Although these problems are often and quite naturally stated in terms of their system or operational implementation, their solutions are usually dependent on a number of mathematical and computer science subdisciplines. For example, some promising approaches to computer vision for automatic target recognition (ATR) require research in a wide range of areas including constructive geometry, numerical methods for stochastic differential equations, Bayesian statistics, tree structured methods in statistics, probabilistic algorithms, and distributed parallel computation. Another example is furnished by simulation. Here improvements depend on a large number of research areas including large scale scientific computing and real time computing for embedded systems. Similarly, recent research on dynamical systems, control theory, logic and concurrency is being applied to the extraction and verification of digital control programs for continuous systems.

In this announcement, Army areas of interest will be described to the potential researcher and user mainly by means of research topics within mathematics and computer science. This procedure has the benefit that our program managers can amplify the worth of their programs by funding research topics that have impact on many different problems.

To be able to respond to the increasing demands on the mathematical and computer sciences, the Army Research Office attempts systematically to advance fundamental knowledge that focuses on the needs of the Army. To accomplish this objective, the Division supports extramural basic research in the following six areas:

- Applied Analysis and Physical Mathematics
- Computational Mathematics
- Stochastic Analysis, Applied Probability and Statistics
- Systems and Control
- Software and Knowledge-Based Systems
- Discrete Mathematics and Computer Science

Each of these six areas is represented by a program. The research supported by the Division does not cover all or even the majority of topics in these six areas. Rather, it covers only certain subareas that are of strategic importance for the Army. Programs typically have two to four foci. There are unavoidable overlaps between programs. The subdisciplinary boundaries within the Division and the disciplinary boundaries in the Army Research Office are not rigidly drawn and there is strong interest in and appreciation for multidisciplinary research in which the mathematical and computer sciences play a major role.

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

II. RESEARCH AREAS

A. Applied Analysis (Dr. John Lavery)

The Applied Analysis Program supports Army needs in mathematical modeling and analysis for advanced solid materials, soil and granular materials, fluid flow (including reactive flow), photonic bandgap materials, nonlinear dynamics and inverse scattering.

Advanced Solid Materials

The Applied Analysis Program supports mathematical research oriented toward optimizing properties or performance characteristics of highly nonlinear materials, including advanced composites for armor and "smart" materials for sensors. Lightweight, high-strength structural components, including advanced composites, contribute to attaining mobility and protection requirements for U.S. forces (as well as to the fuel efficiency and safety of the U.S. automobile fleet). Advanced composites are challenging to analyze and design because of the presence of many interacting length scales. Smart materials are the functional ingredients of actuators, sensors and transducers.

Soil and Granular Materials

Descriptions of granular materials include static and dynamic discrete models, including discrete element models, and continuum models which depend on the size and shape of the grains. There are multiscale problems in abundance in this area. Modeling heterogeneity is important, since locally large fluctuations in force can strongly affect the dynamics of granular materials in distant regions. Large-deformation models of clay soils and other soils for a full range of environmental conditions need to be developed.

Fluid Flow

The characterization of fluid flow, especially reactive fluid flow, is an area in which many (but not all) of the basic equations are well known but which requires further investment because of the presence of vast ranges of length scales and the complexity of the phenomena observed. For characterization and optimization of airflow around rotors and of combustion, detonation and explosion, further research on vortices, vortex motion, turbulence and turbulent diffusion is critical. Research on two-phase flow, such as the break-up of viscous liquid droplets in high-speed airflow, is directly related to defense against biological or chemical weapons transported by theater missiles.

Photonic Bandgap Materials

To determine the flow of EM radiation in a photonic bandgap material, one needs to solve the Maxwell equations in complicated geometry. Solution of the discretized Maxwell equations by finite elements or other procedures is computationally intensive due to the large number of parameters needed to represent the solution and due to the complicated geometry of photonic bandgap materials. The use of mathematical analysis, including boundary integral equations with specialized Green's functions, to design algorithms of great efficiency is a topic of research in the Applied Analysis Program. This area is important for optical control of phased array radar, signature control, identification of friend or foe and protection of personnel and equipment from laser radiation.

Nonlinear Dynamics

Digital communication using nonlinear (chaotic) transmitters and receivers is an exciting area of great importance. The rich characteristics of nonlinear behavior can be used to generate digital signals by simple, lightweight, inexpensive electronic and optical devices with minimal circuitry. The result may be a new digital communication technology with vastly improved bit rate, reduced power requirements and flexibility that will complement and in many instances replace conventional technology. Research in control of chaos, design of alphabets of symbols and synchronization techniques is needed to realize the potential of this area.

Inverse Scattering

Inverse scattering is of interest to the Army for detection and identification of landmines and unexploded ordnance. This is an area involving the interaction between largely unexplored areas of solid mechanics, namely the propagation of various types of waves in soils, and the inverse problem of detecting solid objects having various waveform signatures. Currently available techniques often have high false alarm rates, which impedes mine clearance.

Additional Areas

Topics of potential future interest include mathematical analysis for diffraction-free femtosecond-chirped laser propagation in the atmosphere (for chem/bio detection, laser marking and secure communication), models and performance metrics for information operations (influence on an opponent's decision making and protection of one's own decision making), ultra-lightweight multiscale rod-and-strut materials (for structural components in ground and air vehicles), soil dynamics for vehicle-terrain interaction (for prediction of mobility of ground forces), compressed multiscale representation of terrain and irregular surfaces (for enhanced operational capabilities and combat modeling and simulation), and acoustic sensing systems for physiological and situational monitoring.

B. Computational Mathematics (Dr. Stephen Davis)

The Computational Mathematics Program supports Army needs in producing faster, more stable and accurate solutions to relevant problems in the physical, biological and engineering sciences, and in operations.

Numerical Methods

The areas of interest in numerical methods include methods for efficient numerical solution of nonlinear partial differential equations (both time-dependent and steady state), such as adaptive finite difference and finite element methods, high order methods, gridless methods and methods for computing interfaces, such as front tracking and level sets. Other areas of numerical analysis, such as numerical linear algebra, solution of nonlinear systems and methods for the solution of ordinary differential equations and differential-algebraic equations are of interest to the extent that they address problems of Army interest. Some Army applications may require solutions of numerical problems in real time. The emphasis of the program is on innovative methods for representing data and solving problems, analysis, applicability to Army problems such as rotorcraft flows and penetration mechanics and high performance computing issues, including data management. Multi-scale, multi-model and closure techniques are needed in several applications of importance to the Army. Failure models and dislocation formation in solid mechanics, turbulence modeling, groundwater flow modeling and transport of airborne toxic agents are representative examples. Numerical methods for solving such problems are of considerable interest.

Optimization

Innovative approaches to integer programming, mixed integer programming and nonlinear optimization, especially for large-scale problems, are needed for C^3 applications, vulnerability analysis, logistics, resource management and design of materials (molecular chemistry). Specific topics currently supported include interior-point trust-region approaches to nonlinearly constrained optimization, limited-memory approaches for large-scale optimization, and convergence of optimization methods for singular problems. Parallel computational methods for molecular dynamics with very large numbers of particles, needed for design of new materials, are important. An important area, which has an optimization component and which needs research, is the querying and presenting of large data sets. Optimization, searching, partitioning and mathematical programming are areas that can support research on data management, representation and compression.

C. Stochastic Analysis, Applied Probability, and Statistics (Dr. Robert Launer)

The Stochastic Analysis, Applied Probability and Statistics Program supports critical Army needs in decision making under uncertainty.

Stochastic Analysis and Applied Probability

Army R&D programs directed toward system design, development, testing and evaluation problems generate a need for research in the field of stochastic processes, including stochastic differential equations. Special emphasis is placed on research into methods for the analysis of observations from phenomena modeled by such processes and to numerical methods for stochastic partial differential equations. Research areas of importance to the Army in probability and its applications include stochastic optimization and approximation, stochastic control, large deviations, simulation methodology, spatial processes and image analysis. Ideas are needed from Markov random fields, renormalization of the state space, scaling of time, nonlinear stochastic analysis and infinite-dimensional stochastic differential equations. The techniques required include Brownian flows, infinite-dimensional stochastic processes driven by Poisson noise and Levy noise.

Statistical Methods

There is great interest in statistical methods for very large data sets or very small data sets, sampled from nonstandard, poorly understood distributions. The extraction of more information from small data sets requires improved methods for combining information from disparate sets, as in meta-analysis. Useful statistical models should be based on a thorough understanding of physical processes combined with sound statistical theory. Thus, it is important to integrate statistical procedures with scientific and engineering information about mechanisms as exemplified by a probabilistic methodology that describes the nature of the growth of cracks in different media and the associated statistical analysis. More research is required in several statistical areas including Bayesian methods, Markov random fields, cluster analysis, change point methods, and Markov chain Monte Carlo methods. It is important to bring novel statistical thinking into resource management and optimization in very large communication and logistics networks.

D. Systems and Control (Dr. Linda Bushnell)

The Systems and Control Program is concerned with modeling, analysis and design of complex real-time systems, especially as they relate to Army problems in distributed command, control, and communications and in guidance and control of complex semi-automated and automated systems. The program invests in fundamental control theory, intelligent systems, and design and control of smart structures.

Control Theory

Topics of interest include control in the presence of measurement and model uncertainties, robust and adaptive control for multivariable and nonlinear systems and computational issues related to the design and implementation of real-rime control systems. Some theoretical issues of interest in control theory include adaptive control, robust control, optimal control, stochastic control and nonlinear control. Some practical issues of interest in control theory include hybrid control, telerobotics, micromachines, control issues in wireless communication systems, network control systems, robotics, visual tracking and human dynamics modeling.

Intelligent Systems

Given advances in technology, environmental factors and goals, an intelligent system configures assets to achieve goals or to replan objectives in a fault tolerant fashion either autonomously or for intelligence augmentation of human-centered systems. Intelligent control is the avenue by which regulatory control systems will be expanded to more general functions of decentralized decision making, goal selection, mode switching, assistance to human operators, scenario identification, and system adaptation. Topics of interest include autonomous or semi-autonomous reconfigurable physical agents, computational vision, computational geometry, wireless communications and networks, cognitive issues in man-machine systems, hybrid systems, distributed communication, hierarchical sensing and control, frameworks for representing and reasoning with uncertainty, soft computing and evolutionary approaches to the design of complex systems, and novel modeling and computational paradigms for large intelligent systems.

Design and Control of Smart Structures

The Army is interested in developing an analysis capability that includes a combination of mathematical theories of design, control, analysis and visualization that would aid in the search for an optimal or near-optimal design of smart and adaptive structures. Topics of interest include advancing the state-of-the-art in active control of materials and structures via first principles modeling, analysis and computation, enhancing the theoretical foundations of controlled fluid-structure interactions at various length scales, developing the communications and hierarchical control theory needed for controlling very large arrays of sensors and actuators and developing engineering tools for design and fabrication of controllable materials.

E. Software and Knowledge-Based Systems (Dr. David Hislop)

The program in Software and Knowledge-Based Systems (SKBS) addresses the theoretical bases for the analysis, design, development, and evolution of advanced information-based systems that enable significant improvements in state-of-the-art engineering for software, software-based applications (including modeling and simulation), machine learning, knowledge/acquisition/ representation/synthesis, and knowledgebases/databases. Currently, the research supported by the program is in software prototyping, development and evolution, formal methods for software engineering, and knowledgebase/database sciences.

Software Prototyping, Development and Evolution

Software prototyping, development and evolution require significant investigation into iterative/adaptive graphically driven interfaces; rapid prototyping; software generation, evolution and reuse; software system simulation; distributed software change/evolution; software engineering in domain-specific architectures, tools and tool set integration; software system documentation; and validation and verification. In addition, significant advances in formal methods, the interests in which are described in the next subsection, are required.

Formal Methods for Software Engineering

The interest in this subarea includes global dependencies in software development, the maintenance of these dependencies as software evolves, the interactions among different parts of the process and compatible models for solutions to different parts of the problem. The SKBS Program is interested in research on small-, large- and huge-grain formal methods and software languages, including specification, programming and interface languages. Finally, there is interest in research on real-time software; this research involves the investigation of formal frameworks, deductive methods and tools for the implementation of provably correct (reactive, real-time and hybrid) systems.

Knowledgebase/Database Science

Complex reasoning in a real-world environment requires the ability to integrate data from multiple databases (relational databases, object-oriented databases, geographical information systems, etc.) and data structures as well as to adopt and integrate multiple modes of reasoning such as inconsistency, time, planning, scheduling, reasoning under uncertainty, reasoning under incompleteness and reasoning about pictures, images, and sound. Much of the data/information in the world does not (and will not) reside in any conventional database but rather resides in data exchange (DX) formatted files. Only a few DX formats and their application programming interfaces (API) have database management features. This fact along with other characteristics of DX files leads to a number of research issues such as concurrency control, support of behavioral components and query languages. There is interest in these several areas as well as in content-based retrieval, complex reasoning and machine learning.

F. Discrete Mathematics and Computer Science (Dr. Stephen Davis)

As suggested by the title, the Discrete Mathematics and Computer Science Program supports Army needs in discrete mathematics and theoretical computer science.

Discrete Mathematics

The interests in discrete mathematics are the development and analysis of solution procedures for discrete problems in computational geometry, computational algebra, logic, network flows, graph theory and combinatorics. Specific areas of emphasis include robust geometric computation, solid modeling, multi-resolution methods, parallel and distributed computing and dynamic interactive visualization techniques. Other areas of interest include distributed algorithms for network flows, randomization in computing, computational algebraic geometry techniques for solution of polynomial systems, discrete methods for combinatorial optimization, symbolic methods for differential equations, mixed symbolic-numerical methods for applied problems, parallel symbolic sparse matrix methods, and algorithmic methods in symbolic mathematics arising in, for example, automated reasoning systems, mathematical logic and formal language theory.

Theoretical Computer Science

The interests in this subarea include fundamental issues in parallel computing such as advanced data structures for parallel architectures, parallel algorithms, graph theoretic methods applied to a parallel and distributed computation and models and algorithms for the control of heterogeneous concurrent computing. Also of interest is research on tools for the development of parallel algorithms and expert systems for computation and visualization of solutions to partial differential equations. Exploring fundamental techniques that optimize I/O communication is a research area of great strategic importance.

III. CURRENT PRIORITIES

While the above descriptions reflect the current program, there are areas of higher priority among these. This, of course, does not mean that the Mathematical and Computer Sciences Division will exclude other proposals from consideration, but does reflect the Division's intention to develop programs that take into account evolving research trends as well as changing Army needs. Currently, the high priority areas include nonlinear analysis with emphasis on design of advanced materials, novel algorithmic approaches for large-scale scientific computing, fast algorithms for real-time applications, stochastic analysis with emphasis on simulation methodology and numerical methods, symbolic methods, computational geometry with emphasis on interactive simulation and virtual prototyping, intelligent systems, large databases/knowledgebases and software systems.

PHYSICS

I. INTRODUCTION

II. RESEARCH AREAS

A. Nanoscience

B. Theoretical Physics and Nonlinear Phenomena

C. Quantum Information Science

D. Atomic, Molecular, and Optical (AMO) Physics

E. Surface and Interface Physics

PHYSICS

I. INTRODUCTION

The objective of the Physics Program is to develop and exploit the physics knowledge base for new Army needs and capabilities. The future promises dramatic changes in military capability as a result of physics research. In support of this goal, the interests of the ARO Physics Division are primarily in the following areas: Nanoscience; Theoretical Physics and Nonlinear Dynamics; Quantum Information Science; and Atomic, Molecular, and Optical Physics. Physics disciplines which impact these areas include: (1) Condensed Matter Physics, (2) Interface/Surface Physics, (3) Atomic, Molecular, and Optical Physics, (4) Materials Physics, (5) Cross-Disciplinary topics, and (6) Classical Phenomenology. There is little interest in Relativity and Gravity Physics, Elementary Particles and Field Physics, Nuclear Physics, Astronomy, and Astrophysics since they generally have no impact on the research areas or Army needs. Nevertheless, the possible relevance of topics within these other physics disciplines is not absolutely discounted and discussions of potential exceptions are welcome.

The disciplinary boundaries of the ARO are not sharply drawn as shown by the joint support of a number of efforts by the Physics Division and other ARO Divisions. In addition, it is not necessary that a potential chief investigator be associated with a Physics Department to receive support from the Physics Division. For example, the Physics Division has provided most of the ARO investment in laser research and the chief investigators within the laser program were often associated with Departments of Engineering.

II. RESEARCH AREAS

Please direct inquiries to the attention of the program manager indicated for the particular research area of interest. See page 5 for telephone numbers and e-mail addresses for each of the individual program managers.

A. Nanoscience (Dr. Henry Everitt)

The properties of objects smaller than 100 nanometers may exhibit distinct nonclassical behavior such as quantum confinement, matter waves, and quantum entanglements. The nanoscience thrust exploits such phenomena to demonstrate new or enhanced functionalities that could be exploited for use by the Army. There are three major areas of interest within the nanotechnology workpackage.

Self Assembly of Nanostructures

Specific interest is in the development of techniques for the creation of nanometer-sized materials grown atom-by-atom into a well-defined final state. The objective is twofold: to exploit these nanostructures for investigating and controlling nanoscale phenomena in well-defined nanometer-sized environments and to assemble these nanostructures into novel composite materials which retain the functionalities observed in the nanometer-scale. Additional interests include understanding the evolution of atomic to thin film to bulk behavior. Applications of specific interest include chemical and biological agent detection, optical and infrared photonic crystals, and efficient frequency conversion and optical limiting using enhanced optical nonlinearities.

Electronic and Photonic Band Engineering

Interest continues in the use of electronic band engineering for the demonstration of militarily relevant device functionalities such as infrared emitters based on quantum cascade lasers and lasing without inversion in multiple quantum well semiconductors. Of greater interest is the continuing development and use of photonic band engineered materials for applications including novel microcavity lasers and LEDs, enhanced microwave components, and low emissivity materials. The objective is to use electronic and photonic band engineering independently and together as adjustable design degrees of freedom to develop devices and materials with unique functionality. Methods of solving the inverse problem, finding optimal design rules based on prescribed performance objectives, are of particular interest. Applications include infrared emitters and detectors, low observables, and microphotonics for smart sensors.

Multifunctional Nanoprobes

In order to characterize nanostructures, it is important to combine the high spatial resolution of existing nanoprobes with temporal or spectral resolution of optical probes. The objective is to observe and control the dynamical evolution of physical phenomena in nanostructures. Development of nanometer-scale pump-probe techniques, nanometer-scale feedback and control, and other probes of local behavior are sought to provide new insight into nanoscale phenomena.

B. Theoretical Physics and Nonlinear Phenomena (Dr. Mikael Ciftan)

The Theoretical Physics and Nonlinear Phenomena program is very closely coupled to experimental science as well as to ARO's programs in mathematics, chemistry, biological chemistry, materials science, and engineering sciences. The program thus encompasses a broad base including research in electron physics, photon physics, classical and quantum mechanical systems, and statistical physics. It includes first-principles derivations of thermomechanical strengths of alloys for armor and armor penetrators; electronic band structure calculations of materials for electronic, magnetic, optical, and optoelectronics applications, including those that result from quantum well and multiquantum well structures for signal generation, signal processing, propagation and detection of signals. Also of interest are many-body theoretic approaches that address the electron correlation problem in extended molecular and condensed matter systems to provide the means to predict reaction kinetics, nonequilibrium dynamics, and application to the "alloy problem". There is interest in quantum optics research to explore the role of coherent states, squeezed states, etc. which may provide new tools for improved information processing and means to control information. Statistical physics interests go beyond thermodynamics, into non-equilibrium structures and their metastability, into information theoretic formulations, and into decision algorithms to connect the underlying physics to real world applications via proper modeling, instrumentation and data analysis. The following provides additional details on the subtopics of interest within the Theoretical Physics and Nonlinear Phenomena program.

Theoretical Condensed Matter Physics

The program extends beyond the topical areas of conventional solid state physics. It includes research in liquid crystals (for displays, information processing, etc.), atomic clusters, quantum well structures, superlattices, and metastable structures such as quasi crystals and alloys. It explores fundamental interactions such as electron-phonon coupling, spin-phonon coupling, and polaritons. In addition, it studies the role of elementary interactions such as spin-waves in ferrites and plasmons in multiquantum wells for coherent THz radiation generation. Also of interest are the experimental demonstrations and mathematical underpinnings of enhanced retroreflection and super-enhanced retroreflection of light, which may have unique applications for secure light-wave communication in the battlefield. Another area of interest is the study of "cooperative behavior" which appears in many different forms in solid-state physics, optics, and elsewhere.

The program encompasses research in both classical and quantum domains, from macroscopic (phenomenological/ mean field) to microscopic levels of description of the mechanisms involved. In addition to analytical techniques, it includes the development of new computational methodologies. For example, the use of the principle of maximum entropy, functional integral methods in many-body physics for predicting electron dynamics in quantum well structures, and variants of the density functional method.

Nonlinear Dynamics

Nonlinear interactions that are useful for Army applications appear not only in optics but in other parts of physics, such as in magnetism in the form of magnetostatic solitonic waves for millimeter wave signal processing, in semiconductor multi-quantum well plasmas for generating coherent THz radiation, and in general when an interaction potential significantly deviates from a harmonic form. Defects, both unintentional and intentional, can play major roles. A general theory of "band structure" calculation that takes defects and defect structures correctly and accurately into account will be useful not only for semiconductor science but also for optics and even micromechanics. Many of the elementary excitations of solid state physics could be investigated in light of information processing to increase S/N, density of information and speed of processing. The Theoretical Physics program makes an effort to develop these potentialities vis a vis realistic materials that can embody them, and thereby transition these studies to the Materials Science and Engineering Sciences Divisions for actual implementation.

Nonequilibrium Dynamics

Many aspects of the field of nonequilibrium statistical physics have significant unresolved scientific issues. These issues are not just of academic interest; they impact engineering sciences, from growth of new materials to implementations in neural nets, and also have potential implications for what is dubbed "smart" or "intelligent" systems that have adaptive learning capabilities. This is a vast area if investigation, but our Theoretical Physics program focuses on realistic goals in this area. The physics to be studied should be coupled with actual material mechanisms. In magnetism, this may translate into the study of the coupling of spins to phonons to provide a realistic relaxation mechanism and the associated resonance linewidths. We are interested in magnetic superlattice type structures which can respond to mm waves by forming magnetostatic and magnetooptic waves that have sufficiently long lifetime and propagation distance for signal processing functions. Also, significant theoretical contributions can be made to the science of alloys, via a quantum mechanical calculation of the characteristics of the bonding charge between nearby atomic constituents. This would provide some guidance to "engineer" grain boundaries with specific brittle fracture characteristics needed for Army and civilian applications.

C. Quantum Information Science (Dr. Henry Everitt)

Quantum mechanics provides the opportunity to perform highly nonclassical operations that can result in exponential speed ups in computation or ultra-secure transmittal of information. This workpackage seeks to understand, control, and exploit such nonclassical phenomena for revolutionary advances in computation and secure communication. There are three major areas of interest within this workpackage.

Fundamental Studies

Experimental investigations of the wave nature of matter, including coherence properties, decoherence mechanisms, decoherence mitigation, entanglement, nondestructive measurement, complex quantum state manipulation, and quantum feedback are of interest. The objective is to ascertain the limits of our ability to create, control, and utilize quantum information in multiple quantum entities in the presence of noise. Of particular interest is the demonstration of the ability to manipulate quantum coherent states on time scales much faster than the decoherence time, especially in condensed matter systems where scalability to many quantum bits and quantum operations is promising. Theoretical analyses of nonclassical phenomena may also be of interest if the work is strongly coupled to a specific experimental investigation, as may proof-of-concept demonstrations in atomic, molecular, and optical systems as described in the Atomic, Molecular, and Optical Physics program.

Quantum Computation

Quantum computing will entail the assembly and manipulation of hundreds of quantum bits. The objective is to demonstrate tremendous speed up of computations, and experimental demonstrations of quantum logic performed on several quantum bits operating simultaneously would represent a significant advance toward that ultimate goal. Demonstrations of quantum feedback and error correction for multiple quantum bit systems are also of interest. In addition to the algorithm for factoring, there is particular interest in developing algorithms for solving an NP-complete problem for use in resource optimization and in developing quantum algorithms to simulate complex physical systems.

Quantum Communication

The ability to transmit information through quantum entanglement distributed between spatially separated quantum entities has opened the possibility for an ultra-secure means of communication. Beyond quantum cryptography, the objective is to demonstrate quantum communication of information based on distributed entanglements such as in quantum teleportation. Of particular interest would be the demonstration of long range quantum entanglements, entanglement transfer among different quantum systems, and long term quantum memory.

D. Atomic, Molecular, and Optical (AMO) Physics (Dr. David Skatrud)

Research in atomic, molecular and optical physics will create fundamentally new capabilities for the Army, as well as providing the scientific underpinnings to enhance existing technologies. Topics of interest include unconventional optics for enhanced imaging and detection; atom optics and laser cooling and trapping for ultrasensitive detectors; nonlinear atomic and molecular processes for sensor protection and optical processing; the investigation of plasmas for toxic gas destruction, pollution reduction, materials processing, and propellant ignition. Image science, automatic target recognition, and sensor fusion issues are also addressed in the AMO program.

Unconventional Optics and Imaging

The Division has an interest in extending the capabilities of optical components and systems. Examples of approaches include hybrid optical/digital systems to minimize classical optics aberrations and adaptive optics to mitigate against atmospheric distortions. Also of potential interest are new approaches to coherent or ballistic imaging through turbid and scattering media. Several other imaging enhancement technologies such as hyperspectral imaging and infrared polarimetric imaging having been receiving attention recently. The Division has an interest in the identification and resolution of basic research issues that would demonstrate the utility of these approaches. Also of interest are other approaches that would increase the resolution or contrast of scenes, or otherwise improve the information quality of the images.

Atom Optics

Matter waves offer new or increased capabilities in a number of areas. For example, cooling, trapping and coherent control of atoms and molecules may provide ultrasensitive sensors such as gyroscopes for inertial navigation, or ultrahigh resolution lithography. In addition to the wavelength advantage of matter waves, they also have additional degrees of freedom such as mass that might provide new sensing capabilities. The use of matter waves and Bose condensates requires basic research to better understand issues such a decoherence and optimal trapping techniques, and it requires the development of techniques to transmit, combine, interfere and otherwise manipulate matter waves. Laser cooling and trapping of atoms also may provide proof of principle demonstrations of key components of quantum computing.

The Division also has a general interest in exploring fundamental atomic and molecular physics topics that may have an impact on technologies of interest to the Army. For example electromagnetically induced transparency allows propagation of light through a medium that is normally strongly absorbing, and it may also provides unique access to nonlinear effects that could lead to very efficient frequency multiplication and tunable sources of electromagetic radiation. The understanding of the physical mechanisms behind long range, white light propagation of ultra-short, ultra-intense pulses is another example of a topic of interest with unresolved atomic and molecular physics issues.

Reactive Plasma Phenomena

Low temperature, reactive plasmas have demonstrated significant promise for solving several pressing Army needs: improved chemical warfare agent destruction; the reduction of emissions from diesel engines and flue gases; clean-up of soil contaminated with toxic chemicals; ignition and combustion control of gun propellants; and novel and high performance material science. In spite of the significant promise of plasma technologies, the design, optimization, and implementation of these technologies has been greatly impeded by a lack of a detailed understanding of the plasma chemical, electrical and physical processes. State of the art experimental plasma diagnostics and theoretical modeling/simulation are needed to improve the basic understanding of low-temperature plasma phenomena, and to apply this knowledge to the development of plasma reactors tailored for applications. Of particular interest are approaches to minimize energy requirements, especially for pollution abatement applications that often have severely constraining energy budgets.

Integrated Sensory Science

The ubiquitous presence, especially in Army scenarios, of structured or target-like clutter is a major impediment to all target recognition systems, including both automatic systems and humans. To address this problem, new or improved sensing modalities are of interest. This includes seismic, magnetic, acoustic, tactile and olfactory sensing, in addition to the more widely used electromagnetic sensing. Of particular interest are new types of sensors such as hyperspectral sensors, passive submillimeter wave sensors, stereoscopic imagers, and acoustic sensors. Also of interest are the identification and fusion of complementary information from these sensors, perhaps by real-time adaptive means. For example, self-organizing, inexpensive, arrays of distributed microsensors could provide improved detection and recognition capabilities. The emphasis of the Integrated Sensory Science program is on the underlying issues of information science and image analysis. Other Physics Division programs are concerned with the development of the detectors and sensors themselves.

In many Army scenarios and systems, the performance of image analysis systems is limited by the algorithms and models, rather than the sensors or processors. Even though there has been a large investment in automatic target recognition algorithms, significant shortcomings exist, leading to the need for a renewed emphasis on the theoretical underpinnings. To this end, the Division is interested in innovative research which addresses the following objectives: (1) development of a set of scientific metrics which quantify image content, image complexity, and the performance of image recognition and classification techniques, (2) development of metrics for structured and target-like clutter, (3) development of metrics for assessing and validating synthetic scenes. The ultimate goal is to develop image science to the point that the performance of automatic target recognition systems in arbitrary real-world scenarios can be predicted.

E. Surface and Interface Physics (Dr. Jack Rowe)

Surfaces and Interfaces are important for many phenomena such as film growth, Fermi-level pinning, and quantumconfinement effects. The ARO physics program in this area supplements other physics programs such as Nanoscience and Atomic/Molecular Physics. Novel demonstration projects are considered that are multidisciplinary in the sense of allowing a new capability in surfaces/interfaces and ultrathin film physics. Often projects in this area result from special workshops and focused sessions at major scientific conferences.

PART II

SPECIAL PROGRAMS

CONFERENCE AND SYMPOSIA GRANTS

1. Introduction

The ARO supports conferences and symposia in special areas of science that bring experts together to discuss recent research or education findings or to expose other researchers or advanced graduate students to new research and educational techniques. The ARO encourages the convening in the United States of major international conferences and assemblies of international alliances.

2. Eligibility

Notwithstanding the above, the Department of Defense (DOD) has imposed certain restrictions on ARO's co-sponsorship of scientific and technical conferences and symposia. Specifically, DOD Instruction 5410.20 prohibits co-sponsorship of conferences and symposia with industrial concerns. Scientific, technical, or professional organizations which qualify for tax exemption under the provision of 26 U.S.C. Sec. 501(c)(3) may receive conference and symposia grants. Questions regarding your organization's eligibility for a conference or symposia grant, please contact the ARO Legal Office at (919) 549-4292 or e-mail at Rutter@aro-emh1.army.mil.

3. Conference Support

Conference support proposals should be submitted a minimum of six (6) months prior to the date of the conference.

4. Technical Proposal Preparation

The technical portion of a proposal for support of a conference or symposium should include:

a. A one page or less summary indicating the objectives of the project.

b. The topics to be covered.

c. The location and probable date(s) and why the conference is considered appropriate at the time specified.

d. An explanation of how the conference will relate to the research interests of the ARO and how it will contribute to the enhancement and improvement of scientific, engineering, and/or educational activities as outlined in Part I of the BAA.

e. The name of chairperson(s)/principal investigator(s) and his/her biographical information.

f. A list of proposed participants and the methods of announcement or invitation.

5. Cost Proposal Preparation

The cost portion of the proposal should show:

a. Total project conference costs by major cost elements.

b. Anticipated sources of conference income and amount from each.

c. Anticipated use of funds requested from ARO.

Funds provided by the ARO cannot be used to support participants from communist countries, nor can they be used for payment to any federal government employee for support, subsistence, or services in connection with the proposed conference or symposium.

SHORT TERM INNOVATIVE RESEARCH (STIR) PROGRAM

1. Introduction

The objectives of the STIR program are to fund innovative ideas in basic research. Proposed research may be for the continuation of or the natural outgrowth of experimental or theoretical explorations.

2. Eligibility

Research proposals are sought from educational institutions, nonprofit organizations, and private industry. Prospective offerors of a STIR proposal are encouraged to contact the appropriate ARO program manager identified in Part I of this BAA to ascertain the extent of interest in the specific research project.

3. Research Sought

Proposals in the amount of $20,000 or less are sought for research in the areas identified in Part I of this BAA.

4. Proposal Preparation

Organizations or institutions should submit proposals that are no more than twenty (20) pages in length, inclusive of the budget, transmittal letter, and attachments. Submittal of ten (10) copies of the proposal is required. Any proposal in excess of 20 pages will not be considered. No brochures or explanatory material should be submitted with the proposal. A one-page budget must accompany the proposal.

Proposed research efforts must be "stand alone" and not predicated on the use of any facilities other than those under the direct control of the offeror. Research must be completed within six (6) months of award of the agreement. **Extensions of the six-month performance period will not be granted.**

Proposals shall be submitted with an ARO Proposal Cover Page (ARO Form 51). Limited rights data should be identified as an attachment to the proposal. Otherwise, ARO will assume that the proposal does not contain limited rights data.

No capital equipment may be purchased. Travel costs must not exceed $500. Report preparation costs must not exceed $100. The assessment of indirect costs or fee is unallowable.

The principal investigator(s) should disclose and explain the relevancy of the proposal to the research interests identified in Part I of this BAA.

A brief final technical report must be submitted to ARO within thirty (30) days of completion of the grant or contract. Please note that your award document will reference ARO Form 18, "Reporting Instructions," as found at http://www.aro.army.mil/index.htm. You shall use these reporting instructions for format instructions only; the due date for receipt of a final technical report is thirty (30) days from completion of the award.

Mail proposals to the address found on page 82 with the attention line as ATTN: AMSRL-RO-RI-STIR

YOUNG INVESTIGATOR PROGRAM (YIP)

1. Introduction

The objective of the Young Investigator Program (YIP) is to attract to Army research outstanding young university faculty members, to support their research, and to encourage their teaching and research careers. Young investigators meeting eligibility requirements may submit a YIP proposal. Outstanding YIP projects may be considered for a Presidential Early Career Award for Scientists and Engineers (PECASE). PECASE awards are the highest honor bestowed by the Army on outstanding scientists and engineers beginning their independent careers.

2. Eligibility

This program is open to U.S. citizens holding tenure-track positions at U.S. universities and colleges who have held their graduate degrees (Ph.D. or equivalent) for fewer than five years at the time of application.

3. Research Sought

Proposals are invited for research in areas described in PART I of this BAA. Proposals may be submitted at any time. As is the case for the regular research programs, **we strongly encourage informal discussions with the cognizant ARO technical program manager before submission of a formal proposal.** The ARO does not guarantee an award in each topic area. YIP awards not to exceed $50,000 per year for three years will be made based on research proposals and supporting material. These funds may be used to defray those reasonable costs normally allocable to the research effort (e.g., direct salaries, indirect costs, graduate student support, equipment, supplies, etc.).

4. Proposal Preparation

An individual wishing to apply for a YIP award must submit a research proposal and a supporting letter, each through university officials. Any resulting agreement will be made to the institution, not to the investigator. The research proposal should follow the format set forth in PART IV of the BAA. The institutionally approved proposal and letter should be sent to the address found on page 82 with the attention line as ATTN: AMSRL-RO-RI-YIP.

The supporting letter must be from the applicant's Department Chairperson, Dean, or other official who speaks for the university regarding support for and commitment to the applicant. Strong university support for the applicant is essential. This support can include the applicant's 9-month academic salary, release time from administrative responsibilities, the purchase of equipment, support for the applicant's graduate students, waiver of indirect costs, departmental cost sharing, start-up funding, and so on. It must be clear that the university views the applicant as a truly outstanding, potential leading faculty member and is making a long-term commitment to the applicant and the research.

5. Evaluation Factors

The evaluation factors to be used in determining which proposals are selected for funding are described in PART III of this BAA. In addition, proposals submitted for YIP funding will be evaluated based on a long-term commitment by the university to the applicant and the research. YIP proposals will be selected for award on a competitive basis after a peer or scientific review.

6. Presidential Early Career Award for Scientists and Engineers (PECASE)

An applicant may not directly apply for a PECASE award. Instead, once a year ARO technical program managers will nominate PECASE candidates from among the ARO YIP proposals received and funded that year. The technical program manager will make the PECASE nomination based on strong endorsement of the YIP proposal by the external scientific reviewers and on the great potential shown by the investigator to contribute to science and to the mission of the Army.

Following nomination of a PECASE candidate, a supplemental PECASE proposal will be requested in which the candidate will indicate how PECASE funding would augment the YIP project. PECASE awards are not to exceed $100,000 per year for five years. Supporting information including letters of recommendation, detailed scientific biographical information, and a summary of past research accomplishments will be required in the PECASE proposal

Complete PECASE proposal packages will be evaluated by external scientific reviewers, then by an Army multidisciplinary PECASE panel. The proposals, which demonstrate the greatest potential to contribute to science and to the mission of the Army, will be chosen. Historically, no more than two Army PECASE proposals have been selected for award each year.

7. Continued Support

Support under the YIP is limited to three years and PECASE support is limited to five years. Upon completion of the YIP or PECASE project, young investigators may apply and be considered for continued support in the research areas identified in PART I of this BAA. Decisions about continued funding outside the context of the YIP or PECASE will be made following a peer or scientific review and a review of ARO's research priorities and the creativity and productivity demonstrated during the previous research program.

RESEARCH INSTRUMENTATION

1. Introduction

Research instrumentation is designed to improve the capabilities of U.S. universities to conduct research and educate scientists and engineers in areas important to national defense. Of the funds available to acquire research described in Part I of this BAA, funds may be provided to purchase instrumentation in support of this research or in the development of new research capabilities.

2. Eligibility and Areas of Interest

To be eligible for an instrumentation award, an offeror must have, at the time of submission, a current grant or contract, and the instrumentation requested must be in support of research being presently carried out. It is highly recommended that potential offerors contact the appropriate ARO program manager identified in Part I of this BAA for advice and assistance before preparation of an instrumentation proposal.

3. Content of Request for Instrumentation

The request for instrumentation shall include:

a. A concise abstract (approximately 300 words) that describes the instrumentation requested and the research to be supported by that instrumentation.

b. A budget that addresses equipment to be purchased, cost per item, and total cost. Indicate the proposed source of the equipment and the name and telephone number of a contact at that source. The budget should indicate the amount of funds to be contributed by other sources toward the purchase of the instrumentation.

c. A description of how the proposed instrumentation will: (1) establish new research capabilities, (2) contribute to research currently proposed to DOD, or (3) enhance the quality of research currently being funded by ARO.

d. A description of how the proposed instrumentation will interface with or upgrade other research facilities and instrumentation now available.

e. A description of the amounts and sources of ongoing or proposed support for the research to be supported by the instrumentation.

HISTORICALLY BLACK COLLEGES AND UNIVERSITIES (HBCUs) AND MINORITY INSTITUTIONS (MIs)

1. Introduction

This section is not a special program but is highlighted in this part due to the significant emphasis ARO places on awards to HBCUs/MIs. It is an objective of the ARO to award a fair proportion of its acquisitions to HBCUs and MIs located in the United States. No portion of this BAA will be set aside for HBCU or MI participation due to the impracticality of reserving discrete or severable areas of the research for exclusive competition among the entities.

Before preparation of a proposal, we strongly encourage informal discussion and submission of a brief summary of the proposed research. Key ARO program managers for each area of research interest are identified in Part I of this BAA.

Research collaborations between principal investigators in HBCUs and MIs and scientists in other institutions of higher education (not limited to HBCUs and MIs) are encouraged. Technology sharing and transfer are also encouraged. To this end we welcome proposals that envision university/industry cooperation.

2. Eligibility

Historically black colleges and universities are those institutions determined by the Secretary of Education to meet the requirements of 34 CFR Section 608.2. Minority institutions are those institutions meeting the criteria contained in 10 U.S.C. Section 2323(a)(1)(C), which reads: "minority institutions {as defined in Section 1046(3) of the Higher Education Act of 1965 [20 U.S.C. 1135d-5(3)]}, which, for the purposes of this section, shall include Hispanic-serving institutions [as defined in section 316(b)(1) of such Act (20 U.S.C. 1059c(b)(1)]."

A list of the colleges and universities that meet these criteria is available at http://web.fie.com/web/mol/text/minlist1998.htm.

PART III

PROPOSAL EVALUATION

PROPOSAL EVALUATION

To be eligible for an award of a research agreement, proposals submitted in response to this BAA will be evaluated using the factors listed below (in descending order of importance):

a. The overall scientific and/or technical merits of the proposal.

b. The potential contributions of the effort to the ARO mission and the extent to which the research effort will contribute to balancing the overall ARO research program.

c. The offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposed objectives.

d. The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or other key personnel who are critical to achievement of the proposed objectives.

e. The offeror's record of past performance.

[**NOTE:** If your proposal leads to the award of a contract, proposal evaluation and award performance may be subject to the Office of Federal Procurement Policy's (OFPP) guidance on past performance.]

f. The reasonableness and realism of proposed costs and fee and the availability of funds.

Upon receipt of a proposal, the ARO staff will perform an initial review of its scientific merit and potential contribution to the Army mission and also determine if funds are expected to be available for the effort. Proposals not considered to have sufficient scientific merit or relevance to the Army's needs or those in areas for which funds are not expected to be available may be declined without further review.

It is the policy of the ARO to treat all proposals as privileged information prior to award and to disclose the contents only for the purposes of evaluation. Proposals not declined as a result of an initial review may be subject to an extensive peer review by highly qualified scientists from within the government and leading scientists and other preeminent experts outside the government. While the offeror may restrict the evaluation to scientists from within the government, to do so may prevent review of the proposal by those most qualified in the field of research covered by the proposal. The offeror must indicate on the appropriate proposal form (ARO Form 52 or 52A) any limitation to be placed on disclosure of information contained in the proposal.

Each proposal will be evaluated based on the scientific merit and military relevance of the specific research proposed as it relates to the overall ARO program rather than against other proposals for research in the same general area.

PART IV

PROPOSAL PREPARATION

PROPOSAL PREPARATION

SECTION 1 - INTRODUCTION

This part is intended to provide information needed for preparing research proposals for submission to the ARO.

SECTION 2 - GENERAL INFORMATION

PRELIMINARY INQUIRIES:

The ARO receives several hundred research proposals annually. Because of financial constraints, we are able to provide support for only a limited number of the proposals received. We realize that the preparation of a research proposal often represents a substantial investment of time and effort by the offeror. Therefore, in an attempt to minimize this burden, we strongly encourage organizations and individuals interested in submitting research proposals to make preliminary inquiries as to the general need for the type of research effort contemplated before expending extensive effort in preparing a detailed research proposal or submitting proprietary information. ARO program managers for each area of interest are identified as part of the description of that area.

WHAT PROPOSAL INFORMATION TO INCLUDE:

We prefer that proposal information be provided in two distinct phases:

Phase I (All offerors submitting proposals): All offerors submitting proposals should provide the technical and budgetary (cost) information set forth in Section 3 of this part. From this information, a decision to fund or not to fund the proposed research will be made.

Phase II (Only offerors whose proposals are accepted for funding): For those proposals accepted for funding, we will request, at a later date, additional information necessary for the award of the research agreement. The information to be requested is identified in Section 4 of this Part IV.

ELIGIBILITY:

To be eligible for award of a research agreement, a prospective recipient (except other governments, including state and local governments) must meet certain minimum standards pertaining to financial resources, ability to comply with the performance schedule, prior record of performance, integrity, organization, experience, operational controls, technical skills, facilities, and equipment.

POST EMPLOYMENT CONFLICT OF INTEREST:

There are certain post employment restrictions on former federal officers and employees, including special government employees (Section 207 of Title 18, U.S.C.). If a prospective offeror believes a conflict of interest may exist, the situation should be discussed with ARO procurement and legal personnel prior to expending time and effort in preparing a proposal.

MILITARY RECRUITING:

1. This is to notify potential offerors that each grant or cooperative agreement that is awarded under this announcement to an institution of higher education must include the following term and condition:

"As a condition for receipt of funds available to the Department of Defense (DOD) under this award, the recipient agrees that it is not an institution of higher education (as defined in 32 CFR part 216) that has a policy of denying, and that it is not an institution of higher education that effectively prevents, the Secretary of Defense from obtaining for military recruiting purposes: (A) entry to campuses or access to students on campuses or (B) access to directory information pertaining to students. If the recipient is determined, using the procedures in 32 CFR part 216, to be such an institution of higher education during the period of performance of this agreement, and therefore to be in breach of this clause, the Government will cease all payments of DOD funds under this agreement and all other DOD grants and cooperative agreements to the recipient, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award."

If your institution has been identified under the procedures established by the Secretary of Defense to implement Section 558, then: (1) no funds available to DOD may be provided to your institution through any grant, including any existing grant, (2) as a matter of policy, this restriction also applies to any cooperative agreement, and (3) your institution is not eligible to receive a grant or cooperative agreement in response to this solicitation.

2. This is to notify potential offerors that each contract awarded under this announcement to an institution of higher education shall include the following clause: Defense Federal Acquisition Regulation Supplement (DFARS) clause 252.209-7005, Military Recruiting on Campus.

RESTRICTIVE MARKINGS ON PROPOSALS:

Please complete ARO Form 52 or 52A stating your preference for release of information contained in your proposal. Copies of these forms are provided in Part V of this BAA.

REPORTS REQUIREMENTS:

Reports shall be prepared and submitted in accordance with the *ARO Reporting Instructions,* ARO Form 18. These instructions may be found at http://www.aro.army.mil/index.htm. Basically, the five (5) types of reports required are:

REPORT TYPE	REPORT REQUIREMENT/DESCRIPTION
Progress Reports (Interim) Progress Reports (Final)	1. Due within 90 days of the end of the reporting period, normally 31 December of each research agreement year 2. Report Contents: preferably two pages or less 3. Current Accomplishments 4. Status of Research 5. Report Documentation Page (Standard Form 298) required with each report 1. Due within 90 days of the agreement's expiration 2. Covers entire performance period 3. Report Documentation Page (SF 298) 4. "Memorandum of Transmittal" (included in ARO Form 18*)
Technical Reports	Documents written for the permanent record to convey scientific and technical information on results obtained from activities relating to a single project, task, or agreement. These reports shall be furnished to the ARO as they become available and accompanied by a "Memorandum of Transmittal" and SF 298.
Manuscripts	If submitted for publication, one copy shall be forwarded to the ARO at the same time it is submitted to the journal and accompanied by a "Memorandum of Transmittal."
Reprints	Shall be submitted to the ARO as they become available and accompanied by a "Memorandum of Transmittal" and SF 298.
Forecast Expenditure Reports	A partial report is generated by ARO and forwarded to the principal investigator for completion 90 days before the exercise of options or funding increments. Recipient completes SECTION 2 and returns it to the ARO Scientific Officer within 30 days of receipt.

*For detailed and complete reporting instructions, please refer to the ARO Form 18.

The number and types of reports will be specified in the research agreement.

NOTE: Reporting requirements for certain programs are not as stated above. Due to the nature and brevity of programs other than the ARO single investigator (core) programs (as described herein), the requirements shall be outlined in the individual research agreement.

SUBCONTRACTING:

Pursuant to Section 8(d) of the Small Business Act [15 U.S.C. 637(d)], it is the policy of the Government to enable small business concerns to be considered fairly as subcontractors under all research agreements awarded to prime contractors and grantees.

EQUIPMENT:

Title to equipment or other tangible property purchased with contract funds may be vested in nonprofit institutions of higher education or with nonprofit organizations whose primary purpose is the conduct of scientific research. Normally title will vest in the recipient if vesting will facilitate scientific research performed by the institution or organization for the Government. Commercial organizations are expected to possess the necessary plant and equipment to conduct the proposed research.

DEFINITIONS:

1. Grant and Cooperative Agreement - A written document showing agreement between the ARO and an eligible recipient by which the ARO agrees to provide the recipient a stated sum of Research, Development, Test, and Evaluation (RDTE) funds and the recipient agrees to use such funds to perform research identified in an approved proposal of the recipient. The authority for grant and cooperative agreement awards is set forth in 10 U.S.C. 2358. The criteria for using these documents are identified in 31 U.S.C. 6304-6305. Grants and cooperative agreements are governed by the following regulations:

a. OMB Circular A-21, "Cost Principles for Educational Institutions"

b. OMB Circular A-87, "Cost Principles for State, Local and Indian Tribal Governments"

c. OMB Circular A-102, "Grants and Cooperative Agreements with State and Local Governments"

d. OMB Circular A-110, "Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations"

e. OMB Circular A-122, "Cost Principles for Non-Profit Organizations"

f. OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations"

g. DOD Grant and Agreement Regulations (DODGARs), DOD 3210.6-R

Copies of OMB regulations may be obtained from:

Executive Office of the President
Publications Service
New Executive Office Building
725 17th Street, N.W., Room 2200
Washington, DC 20503

Telephone: (202) 395-7332
FAX Requests: (202) 395-9068
http://www.whitehouse.gov/WH/EOP/OMB/html/circular.html

An electronic copy of the DODGARs may be found at http://web7.whs.osd.mil/pdf/32106r/32106r.htm.

2. Historically Black Colleges and Universities - Institutions determined by the Secretary of Education to meet the requirements of 34 CFR Section 608.2.

3. Minority Institutions - Institutions defined as those meeting the criteria contained in 10 U.S.C. Section 2323(a)(1)(C), which reads: "minority institutions [as defined in Section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5(3)], which, for the purposes of this section, shall include Hispanic-serving institutions [as defined in Section 316(b)(1) of such Act (20 U.S.C. 1059c(b)(1)]."

4. Research Agreement - As used herein, the term refers to research contracts, grants, and cooperative agreements.

5. Small Business Concern - A concern that is independently owned and operated, organized for profit, is not dominant in the field of operation in which it is bidding on Government contracts, and with its affiliates employs not more than 500 employees.

6. Small Disadvantaged Business Concern - A small business concern which is at least 51 per cent owned by one or more socially and economically disadvantaged individuals; or, in the case of any publicly owned business, at least 51 per cent of the stock of which is owned by one or more socially and economically disadvantaged individuals and whose management and daily business operations are controlled by one or more of such individuals.

PROPOSAL PREPARATION AND SUBMISSION:

Proposals may be submitted at any time. In preparing a proposal, it is important that the offeror keep in mind the characteristics of a suitable proposal acceptable for formal evaluation. It should include all the information specified in this BAA in order to avoid delays in evaluation. A proposal for continuation of a given research project will be considered on the same basis as proposals for other new research agreements. The proposal should be submitted sufficiently in advance of the termination of the existing agreement so that if it is accepted, support may be continued without interruption.

Submittal of ten (10) copies of the proposal is required. Each copy must contain any restrictive legends (see guidance provided above). Do not submit the proposal to individual program managers; this could delay the receipt and review of the proposal.

Mail proposals to: **[For deliveries by the Federal Government's United States Postal Service (USPS)]**

Director
U.S. Army Research Office
ATTN: AMSRL-RO-RI (DAAD19-99-R-BAA1)
P. O. Box 12211
Research Triangle Park, NC 27709-2211

[If you plan to hand-deliver your proposal or use special mail services such as FedEx, DHL, Airborne, the following street address and zip code must be included. Please note that a different city and zip code than that for regular USPS mail are used.]

Director
U.S. Army Research Office
ATTN: AMSRL-RO-RI (DAAD19-99-R-BAA1)
4300 South Miami Boulevard
Durham, NC 27703-9142

In the European hemisphere:

U.S. Army European Research Office
USARDSG-UK
PSC 802 Box 15
FPO AE 09499-1500

UNSUCCESSFUL PROPOSAL DISPOSITION:

Unless noted in an offeror's proposal to the contrary, unsuccessful proposals will be retained for six (6) months from declination and then properly destroyed.

DOD CENTRAL CONTRACTOR REGISTRATION DATABASE:

In accordance with DOD policy, prospective contractors must be registered in the Central Contractor Registration (CCR) database prior to award of a contract, basic agreement, basic ordering agreement, or blanket purchase agreement. By submission of an offer resulting from this BAA, the offeror acknowledges the requirement that a prospective contractor must be registered in the CCR database prior to award, during performance, and through final payment of any contract resulting from this BAA. Even though this requirement is applicable to contractors, the ARO strongly encourages potential grantees to register also.

YEAR 2000 COMPUTER COMPLIANCE:

Recipients of ARO research agreements have full responsibility for the scientific, administrative, and financial aspects of the activity being supported. This responsibility extends to anticipating and preparing for the Year 2000 and taking appropriate actions to ensure that the ARO activity being supported is not adversely affected by a Year 2000 problem. Potentially affected items include: computer systems, databases, and equipment. If an application deals with future dates, that application must be Year 2000 compliant before the first use of dates beyond 31 December 1999. The ARO should be notified if an awardee concludes that the Year 2000 will have a significant impact on its ability to carry out an ARO funded activity.

SECTION 3 - CONTENTS OF RESEARCH PROPOSALS (PHASE I)

All offerors preparing research proposals for submission to the ARO should initially submit the following information:

- Cover page (ARO Form 51)
- Table of Contents
- Statement of Disclosure Preference (ARO Form 52 or 52A)
- Project Abstract
- Technical Proposal (Project Description)
- Biographical Sketch
- Bibliography
- Current and Pending Support
- Facilities, Equipment, and Other Resources
- Budget Proposal (ARO Form 99)
- Contract Facilities Capital Cost of Money (where applicable)
- Appendices (if applicable)

COVER PAGE (ARO FORM 51):

See Part V of this BAA for the required Cover Page (ARO Form 51). Should the project be carried out at a branch campus or other component of the submitting organization, that branch campus or component should be identified in the space provided.

The title of the proposed project should be brief, scientifically representative, intelligible to a scientifically literate reader, and suitable for use in the public press.

The proposed duration for which support is requested should be consistent with the nature and complexity of the proposed activity. Awards may be made for periods up to three (3) years (1 basic year of performance with two 1-year options). The ARO reserves the right, however, to make awards with shorter or longer periods of performance.

Specification of a desired starting date for the project is important and helpful to the ARO staff; however, requested effective dates cannot be guaranteed. Should unusual situations, such as long lead-time on awards, create problems regarding the proposed effective date, the investigator should consult the proposing organization's business office.

Should any of the special aspects apply to a proposal, the approximate box(es) should be checked.

Pursuant to 31 U.S.C. 7701, as amended by the Debt Collection Improvement Act of 1996 [section 31001(I)(1), Public Law 104-134], federal agencies shall obtain each awardee's Taxpayer Identification Number (TIN). This number may be the Employer Identification Number for a business or non-profit entity or the Social Security Number for an individual. The TIN is being obtained for purposes of collecting and reporting on any delinquent amounts that may arise out of an awardee's relationship with the Government.

Offerors shall provide their organization's Data Universal Numbering System (DUNS) number. The DUNS number is a nine-digit number assigned by Dun and Bradstreet Information Services.

If known, offerors shall provide their assigned Commercial and Government Entity (CAGE) Code. The CAGE Code is a 5-character code assigned and maintained by the Defense Logistics Service Center (DLSC) to identify a commercial plant or establishment.

Proposals must be cleared through the organizational officer having responsibility for Government business relations. An official authorized to commit the organization in business and financial affairs must sign the original copy of the Cover Page. Other copies provided may be reproductions.

TABLE OF CONTENTS:

Part V of this BAA contains the required Table of Contents form. Offerors' proposals should show the location of each section of the proposal, as well as major subdivisions of the project description.

STATEMENT OF DISCLOSURE PREFERENCE (ARO FORM 52 OR 52A):

Complete ARO Form 52 (Industrial Contractors) or ARO Form 52A (Educational and Nonprofit Organizations) as provided in Part V.

PROJECT ABSTRACT:

The Project Abstract shall include a concise statement of work and basic approaches to be used in the proposed effort. The abstract should include a statement of objectives, methods to be employed, and the significance of the proposed effort to the advancement of knowledge.

The abstract should be no longer than one (1) page and be in a form suitable for release under the Freedom of Information Act, 5 U.S.C. 552, as amended. The abstract should indicate the effort intended for each 12-month period of research.

TECHNICAL PROPOSAL (PROJECT DESCRIPTION):

The technical portion of the proposal should be submitted on the form found in Part V of this BAA and shall contain the following:

a. A complete discussion stating the background and objectives of the proposed work, the approaches to be considered, and the level of effort to be employed. Include also the nature and extent of the anticipated results and, if known, the manner in which the work will contribute to the accomplishment of the agency's mission.

b. A brief description of your organization. If the offeror has extensive government contracting experience and has previously provided the information to the ARO, the information need not be provided again. A statement setting forth this condition should be made.

c. The names of other federal, state, local agencies, or other parties receiving the proposal and/or funding the proposed effort. If none, so state. Concurrent or later submission of the proposal to other organizations will not prejudice its review by the ARO if we are kept informed of the situation.

d. A statement regarding possible impact, if any, of the proposed effort on the environment considering as a minimum its effect upon water, atmosphere, natural resources, human resources, and any other values.

e. The offeror shall provide a statement regarding the use of Class I and Class II ozone-depleting substances. Ozone-depleting substances mean any substance designated as Class I by EPA, including but not limited to chlorofluorocarbons, halons, carbon tetrachloride, and methyl chloroform and any substance designated as Class II by EPA, including but not limited to hydrochlorofluorocarbons. See 40 C.F.R. Part 82 for detailed information. If Class I or II substances are to be utilized, a list shall be provided as part of the offeror's proposal. If none, so state.

f. The type of support, if any, requested (e.g., facilities, equipment, materials).

BIOGRAPHICAL SKETCHES:

This Section shall contain the biographical sketches for senior personnel only. The following information is required:

a. Relevant experience and employment history including a description of any prior Federal employment within one year preceding the date of proposal submission.

b. List of up to five (5) publications most closely related to the proposed project and up to five (5) other significant publications, including those being printed. Patents, copyrights, or software systems developed may be substituted for publications.

c. List of persons, other than those cited in the publications list, who have collaborated on a project or a book, article, report or paper within the last four (4) years. Include pending publications and submissions. Otherwise, state "None."

d. Names of each investigator's own graduate or post graduate advisors and advisees.

The information provided in "c" and "d" is used to help identify potential conflicts or bias in the selection of reviewers.

For the personnel categories listed below, the proposal may include information on exceptional qualifications of the individuals that merit consideration in the evaluation of the proposal.

a. Postdoctoral associates

b. Other professionals

c. Students (research assistants)

The biographical sketches are limited to three (3) pages per investigator and other individuals that merit consideration. See Part V of this BAA for the appropriate format. This format may be reproduced as needed.

BIBLIOGRAPHY:

A bibliography of pertinent literature is required. Citations must be complete (including full name of authors, title, and location in the literature). See Part V of this BAA for the appropriate format.

CURRENT AND PENDING SUPPORT:

Part V of the BAA provides a model format for reporting all current, on-going projects and pending support for proposals, including subsequent funding in the case of continuing award agreements. All project support from whatever source must be listed. The list must include all projects requiring a portion of the principal investigator's and other senior personnel's time, even if they receive no salary support from the project(s).

The information should include, as a minimum: (1) the project/proposal title and brief description, (2) the name and location of the organization or agency presently funding the work or requested to fund such work, (3) the award amount or annual dollar volume of the effort, (4) the period of performance, and (5) a breakdown of the time required of the principal investigator and/or other senior personnel.

FACILITIES, EQUIPMENT, AND OTHER RESOURCES:

The offeror should include in the proposal a listing of facilities, equipment, and other resources already available to perform the effort proposed.

BUDGET PROPOSAL (including DD Form 1861):

Each proposal must contain a budget for each year of support requested and a cumulative budget for the full term of requested support. The budget form (ARO Form 99) found in Part V of this BAA may be reproduced as needed. Locally produced versions may be used, but you may not make substitutions in prescribed budget categories nor alter or rearrange the cost categories as they appear on the form. The proposal may request funds under any of the categories listed so long as the item is considered necessary to perform the proposed work and is not precluded by applicable cost principles. In addition to the forms, the budget proposal should include up to five (5) pages of budget justification for each year. A summary budget page should be included. The documentation pages should be titled "Budget Explanation Page" and numbered chronologically starting with the budget form. The need for each item should be explained clearly.

All cost data must be current and complete. Costs proposed must conform to the following principles and procedures:

Educational Institutions: OMB Circular A-21
Nonprofit Organizations: OMB Circular A-122*
Industrial Organizations: FAR Part 31 and DFARS Part 231

**For those nonprofit organizations specifically exempt from the provisions of OMB Circular A-122, FAR Part 31 and DFARS Part 231 shall apply.*

The itemized budget(s) must include the following:

a. Direct Labor: Show the current and projected salary amounts in terms of man-hours, man-months, or annual salary to be charged by the principal investigator(s), faculty, research associates, postdoctoral associates, graduate and undergraduate students, secretarial, clerical, and other technical personnel either by personnel or position. State the number of man-hours used to calculate a man-month or man-year. For proposals from universities, research during the academic term is deemed part of regular academic duties, not an extra function for which additional compensation or compensation at a higher rate is warranted. Consequently, academic term salaries shall not be augmented either in rate or in total amount for research performed during the academic term. Rates of compensation for research conducted during non-academic (summer) terms shall not exceed the rate for the academic terms.

When part or all of a person's services are to be charged as project costs. it is expected that the person will be relieved of an equal part or all of his or her regular teaching or other obligations. For each person or position, provide the following information:

(1) The basis for the direct labor hours or percentage of effort (e.g., historical hours or estimates).

(2) The basis for the direct labor rates or salaries. Labor costs should be predicated upon current labor rates or salaries. These rates may be adjusted upward for forecast salary or wage cost-of-living increases that will occur during the agreement period. The cost proposal should separately identify the ratio applied to base salary/wage for cost-of living adjustments and merit increases. Each must be fully explained.

(3) The portion of time to be devoted to the proposed research, divided between academic and non-academic (summer) terms, when applicable.

(4) The total annual salary charged to the research project.

(5) Any details that may affect the salary during the project, such as plans for leave and/or remuneration while on leave.

b. Fringe Benefits and Indirect Costs (Overhead, General and Administrative, and Other): The most recent rates. dates of negotiation, the base(s) and periods to which the rates apply must be disclosed and a statement included to identify whether the proposed rates are provisional or fixed. If the rates have been negotiated by a Government agency, state when and by which agency. **A copy of the negotiation memorandum should be provided.** If negotiated forecast rates do not exist, offerors must provide sufficient detail to enable the ARO to determine that the costs included in the forecast rate are allocable according to applicable OMB Circulars or FAR/DFARS provisions. Offerors' disclosure should be sufficient to permit a full understanding of the content of the rate(s) and how it was established. As a minimum, the submission should identify:

(1) All individual cost elements included in the forecast rate(s);

(2) Bases used to prorate indirect expenses to cost pools, if any;

(3) How the rate(s) was calculated;

(4) Distribution basis of the developed rate(s):

(5) Bases on which the overhead rate is calculated, such as "salaries and wages" or "total costs," and

(6) The period of the offeror's fiscal year.

c. Permanent Equipment: If facilities or equipment are required, a justification why this property should be furnished by the Government must be submitted. State the organization's inability or unwillingness to furnish the facilities or equipment. Offerors must provide an itemized list of permanent equipment showing the cost for each item. Permanent equipment is any article of tangible nonexpendable property having a useful life of more than one year and an acquisition cost of $5,000 or more per unit. The basis for the cost of each item of permanent equipment included in the budget must be disclosed, such as:

(1) Vendor Quote: Show name of vendor, number of quotes received and justification, if intended award is to other than lowest bidder.

(2) Historical Cost: Identify vendor, date of purchase. and whether or not cost represents lowest bid. Include reason(s) for not soliciting current quotes.

(3) Engineering Estimate: Include rationale for quote and reason for not soliciting current quotes.

If applicable. the following additional information shall be disclosed in the offeror's cost proposal:

(4) Special test equipment to be fabricated by the awardee for specific research purposes and its cost.

(5) Standard equipment to be acquired and modified to meet specific requirements, including acquisition and modification costs, listed separately.

(6) Existing equipment to be modified to meet specific research requirements, including modification costs. Do not include equipment the organization will purchase with its funds if the equipment will be capitalized for Federal income tax purposes.

The purchase of non-U.S.-manufactured equipment requires special authorization under the Buy American Act. Time required to process such approvals is approximately ninety (90) days.

Proposed permanent equipment purchases during the final year of an award shall be limited and fully justified.

Grants, cooperative agreements, or contracts may convey title to the institution for equipment purchased with project funds. At the discretion of the contracting/grants officer, the agreement may provide for retention of the title by the Government or may impose conditions governing the equipment conveyed to the organization. The Government will not convey title to commercial contractors.

NOTE: It is the policy of the DOD that all commercial and nonprofit contractors provide the equipment needed to support proposed research. In those rare cases where specific additional equipment is approved for commercial and nonprofit organizations, such approved cost elements shall be "nonfee-bearing." In addition, commercial contractors are precluded from using contract funds to acquire facilities with a unit acquisition cost of $10,000 or less (see FAR 45.302-1).

d. Travel: Forecasts of travel expenditures (domestic and foreign) that identify the destination and the various cost elements (airfare, mileage, per diem rates, etc.) must be submitted. The costs should be in sufficient detail to determine the reasonableness of such costs. Allowance for air travel normally will not exceed the cost of round-trip, economy air accommodations. Specify the type of travel and its relationship to the research project. Requests for domestic travel must not exceed $2,500 per year per principal investigator. Separate, prior approval by the ARO is required for all foreign travel (i.e., travel outside the continental U.S., its possessions and Canada). Foreign travel requests must not exceed $1,800 each per year per principal investigator. Special justification will be required for travel requests in excess of the amounts stated above and for travel by individuals other than the principal investigator(s). Individuals other than the principal investigator(s) are considered postdoctoral associates, research associates, graduate and undergraduate students, secretarial, clerical, and other technical personnel. Additional travel may be requested for travel to Army laboratories and facilities to enhance agreement objectives and to achieve technology transfer.

e. Participant Support Costs: This budget category refers to costs of transportation, per diem, stipends, and other related costs for participants or trainees (but not employees) in connection with ARO-sponsored conferences, meetings, symposia, training activities and workshops (see Part III - Special Programs). Generally, indirect costs are not allowed on participant support costs. The number of participants to be supported should be entered in the parentheses on the budget form. These costs should also be justified in the budget justification/explanation section attached to the cost proposal.

f. Materials, Supplies, and Consumables: A general description and total estimated cost of expendable equipment and supplies are required. The basis for developing the cost estimate (vendor quotes, invoice prices, engineering estimate, purchase order history, etc.) must be included. If possible, provide a material list.

g. Publication, Documentation, and Dissemination: The budget may request funds for the costs of preparing, publishing, or otherwise making available to others the findings and products of the work conducted under an ARO agreement, including costs of reports, reprints, page charges, or other journal costs (except costs for prior or early publication); necessary illustrations; cleanup, documentation, storage, and indexing of data and databases; and development, documentation, and debugging of software.

h. Consultant Costs: Offerors normally are expected to utilize the services of their own staff to the maximum extent possible in managing and performing the project's effort. If the need for consultant services is anticipated, the nature of proposed consultant services should be justified and included in the technical proposal narrative. The cost proposal should include the names of consultants(s), primary organizational affiliation, each individual's expertise, daily compensation rate, number of days of expected service, and estimated travel and per diem costs.

i. Computer Services: The cost of computer services, including computer-based retrieval of scientific, technical, and educational information may be requested. A justification/explanation based on the established computer service rates at the proposing organization should be included. The budget also may request costs, which must be shown to be reasonable, for leasing automatic data processing equipment. The purchase of computers or associated hardware and software should be requested as items of equipment.

j. Subawards: A precise description of services or materials that are to be awarded by a subaward must be provided. For subawards totaling $10,000 or more, provide the following specific information:

(1) A clear description of the work to be performed.

(2) If known, the identification of the proposed subawardee and an explanation of why and how the subawardee was selected or will be selected.

(3) The identification of the type of a ward to be used (cost reimbursement, fixed price, etc.).

(4) Whether or not the award will be competitive and, if noncompetitive, rationale to justify the absence of competition.

(5) A detailed cost summary.

k. Other Direct Costs: Itemize and provide the basis for proposed costs for other anticipated direct costs such as communications, transportation, insurance, and rental of equipment other than computer related items. Unusual or expensive items shall be fully explained and justified.

l. Fixed Fee and Cost of Money: The fixed fee, if any, which the organization proposes to assess the research project. If cost of money is proposed, a completed Contract Facilities Capital Cost of Money (FCCM) (DD Form 1861) is required.

APPENDICES:

Some situations require that special information and supporting documents be included in the proposal before funding can be approved. Such information and documentation should be included by appendix to the proposal.

SECTION 4 - INFORMATION TO BE REQUESTED FROM SUCCESSFUL OFFERORS (PHASE II)

Offerors whose proposals are accepted for funding will be contacted before award to provide additional information required for award. The required information is normally limited to clarifying budget explanations, representations, and certifications.

SECTION 5 - CERTIFICATIONS REQUIRED FOR ASSISTANCE AWARDS

a. Certification for Contracts, Grants, Loans, and Cooperative Agreements

By signing and submitting a proposal that may result in the award of a grant or cooperative agreement exceeding $100,000, the prospective awardee is certifying, to the best of his or her knowledge and belief, that:

"(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying,' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty or not less than $10,000 and not more than $100,000 for each such failure."

b. Certification Regarding Debarment, Suspension, and Other Responsibility Matters --Primary Covered Transactions

(1) By signing and submitting this proposal, the prospective primary participant is providing the certification set out below.

(2) The inability of a person to provide the certification required below will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such person from participation in this transaction.

(3) The certification in this clause is a material representation of fact upon which reliance was placed when the department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

(4) The prospective primary participant shall provide immediate written notice to the department or agency to which this proposal is submitted if at any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

(5) The terms "covered transaction," "debarred," suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive order 12549. You may contact the department or agency to which this proposal is being submitted for assistance in obtaining a copy of those regulations.

(6) The prospective primary participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is proposed for debarment under 48 CFR part 9, subpart 9.4, debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

(7) The prospective primary participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

(8) A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not proposed for debarment under 48 CFR part 9, subpart 9.4, debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the List of Parties Excluded from Federal Procurement and Nonprocurement Programs.

(9) Nothing contained in the foregoing shall be construed to require establishment of a system or records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

(10) Except for transactions authorized under paragraph 6 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is proposed for debarment under 48 CFR part 9, subpart 9.4, suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

Certification Regarding Debarment, Suspension, and Other Responsibility Matters--Primary Covered Transactions

"(1) The prospective primary participant certifies to the best of its knowledge and believe, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property.

(c) Are not presently indicated for or otherwise criminally or civilly charged by a government entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification such prospective participant shall attach an explanation to this proposal."

c. Certification Regarding Drug-Free Workplace Requirements

(1) By signing and/or submitting this application or grant agreement, the grantee is providing the certification set out below.

(2) The certification set out below is a material representation of fact upon which reliance is placed when the agency awards the grant. If it is later determined that the grantee knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the agency, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

(3) For grantees other than individuals, Alternate I applies.

(4) For grantees who are individuals, Alternate II applies.

(5) Workplaces under grants, for grantees other than individuals, need not be identified on the certification. If known, they may be identified in the grant application. If the grantee does not identify the workplaces at the time of application, or upon award, if there is no application, the grantee must keep the identity of the workplace(s) on file in its office and make the information available for Federal inspection. Failure to identify all known workplaces constitutes a violation of the grantee's drug-free workplace requirements.

(6) Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or State highway department while in operation, State employees in each local unemployment office, performers in concert halls or radio studios).

(7) If the workplace identified to the agency changes during the performance of the grant, the grantee shall inform the agency of the change(s), if it previously identified the workplaces in question (see paragraph five).

(8) Definitions of terms in the Nonprocurement Suspension and Debarment common rule and Drug-Free Workplace common rule apply to this certification. Grantees' attention is called, in particular, to the following definitions from these rules;

Controlled substance means a controlled substance in schedules I through V of the Controlled Substances Act (21 U.S.C. 812), and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) All "direct charge" employees; (ii) all "indirect charge" employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantee's payroll; or employees of subrecipients or subcontractors in covered workplaces).

Certification Regarding Drug-Free Workplace Requirements
(Alternate I - Grantees Other Than Individuals)

"A. The grantee certifies that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about--

(1) The dangers of drug abuse in the workplace;

(2) The grantee's policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will--

(1) Abide by the terms of the statement; and

(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(e) Notifying the agency in writing, within ten calendar days after receiving notice under paragraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grants officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (d)(2), with respect to any employee who is so convicted--

(1) Taking appropriate personnel action against such employee, up to an including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

____
____
____

Check ☐ if there are workplaces on file that are not identified here."

(Alternate II - Grantees Who Are Individuals)

"(a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;

(b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing within 10 calendar days of the conviction, to every grants officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number (s) of each affected grant."

PART V

PROPOSAL FORMS

Solicitation Number:

ARMY RESEARCH OFFICE PROPOSAL COVER PAGE

ARO Proposal Number

1. SUBMIT 10 COPIES OF PROPOSAL TO:

Director
U.S. Army Research Office
ATTN: AMSRL-RO-RI
P.O. Box 12211
Research Triangle Park, NC 27709-2211

2. For consideration by ARO Organization Unit(s):
☐ Biology ☐ Materials
☐ Chemistry ☐ Mathematics
☐ Computer Science ☐ Physics
☐ Electronics
☐ Engineering
☐ Environmental Sciences

3. Is this proposal being submitted to another Federal Agency?
☐ No ☐ Yes If Yes, list the agency:

4. Is applicant delinquent on any Federal Debt?
☐ Yes (Attach explanation) ☐ No

5. Proposal Valid Until (min of 6 mos):

6. Entity Identification Number (EIN) or Taxpayer Identification Number (TIN)

7. Data Universal Numbering System (DUNS No.):

8. Commercial and Government Entity (CAGE) Code:

9. Name of organization to which award should be made:

10. Administrative Address of Organization (if different):

11. Branch/Campus/Other Component (where work is performed, if different):

12. Submitting Organization's Contract/Grant Administration Office:

13. Submitting Organization's Audit Office:

14. Submitting Organization: (Check all that apply)
☐ For Profit: ☐ Large ☐ Small ☐ Disadvantaged ☐ 8a ☐ Women-Owned ☐ Foreign ☐ Individual
☐ Educational: ☐ HBCU ☐ Minority Institution ☐ State ☐ Private ☐ Foreign ☐ FDP
☐ Hospital: ☐ Public ☐ Private ☐ Nonprofit ☐ For Profit
☐ Nonprofit
☐ Not-For-Profit
☐ Other (Specify)

15. Check appropriate box(es) if this proposal includes any of the items listed below:
☐ Human Subjects ☐ Recombinant DNA
☐ Vertebrate Animals ☐ Genetically Engineered Organisms
☐ National Environment Policy Act ☐ Limited Rights Data
☐ Disclosure of Lobbying Activities ☐ Historical Places

16. Proposed Amount:

17. Proposed Duration (1-60 mos):

18. Proposed Start Date:

19. Type of Award Proposed:
☐ Single Investigator
☐ Young Investigator Program
☐ Short Term Innovation Rsch
☐ Research Instrumentation
☐ HBCU/MI
☐ Other (specify):

20. Title of Proposed Project:

21. Principal Investigator (PI)/Project Director (PD) Department and Postal Address:

TYPED NAMES	TELEPHONE NUMBER	FACSIMILE NUMBER	ELECTRONIC MAIL ADDRESS
22. PI/PD			
23. CO-PI/PD			
24 a. Primary Administrative Representative Authorized to Conduct Negotiations:			
24 b. Alternate Administrative Representative Authorized to Conduct Negotiations:			

25 a. Authorized Representative Signing for Applicant Organization:

25 b. Title:

25 c. By signing and submitting this proposal, the offeror is providing the certifications found in Part IV, Section 5.

25 d. Signature Date:

ARO Form 51 (REV Oct 98) PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

PROPOSAL

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List Appendix Items:______________

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PROTECTION OF PROPRIETARY INFORMATION DURING EVALUATION AND AFTER AWARD

It is the policy of the US Army Research Office to treat all research proposals as privileged information prior to award and to disclose the proposal contents only for evaluation purposes. Technical evaluation of these proposals normally are made by highly qualified scientists from the Government and leading scientists and other preeminent experts outside the Government to ascertain their merits. If you wish, you may restrict the evaluation of your proposal to only scientists within the Government. To do so may prevent it from receiving an evaluation by those most qualified to evaluate it. Therefore, we ask permission to send your proposal outside the Government, if necessary, to obtain an unrestricted evaluation.

All reviewers are made aware that proposals sent to them for evaluation shall not be duplicated, used, or disclosed in whole or in part for any other purpose without the written permission of the offeror.

You should be aware that despite all precautions, we can protect the confidentiality of proprietary information contained in proposals only to the extent that it is exempt from disclosure under the Freedom of Information Act (FOIA; 5 U.S.C. 552). Generally, Exemption 4 of the FOIA [5 U.S.C. 552(b)(4)] will protect from release information submitted to the Government that constitutes either (1) a trade secret or (2) commercial or financial information which is privileged or confidential. Any such proprietary information contained in your proposal should be marked in accordance with FAR 15.608.

Please complete the following statement indicating your proposal treatment preference during the evaluation phase and, should a contract be awarded, afterwards.

STATEMENT OF DISCLOSURE PREFERENCE

______________________________ in submitting proposal titled ______________________________

(Organization)

______________________________ with ______________________________

(Name)

as Principal Investigator requires the following procedure be used during its evaluation:

() Permission is hereby granted to the US Army Research Office to evaluate this proposal in accordance with its normal procedures which may include evaluation by reviewers both within and outside the Government. Written agreement not to disclose the information contained therein shall be obtained from any nongovernment evaluators. Permission to release outside the Government, for evaluation purposes only, those pages of the proposal marked in accordance with FAR 15.608 is hereby granted, except for the following pages or sections:

____

____

() Restrict the evaluation of the above proposal to Government reviewers only.

To reduce administrative requirements, you may complete the following information by checking the appropriate blocks:

If this proposal results in a contract, the offeror grants ARO the authority to release the following portion of its proposal in response to requests under the Freedom of Information Act, only after such award, without prior contact with the offeror.

Cover Page	☐ Yes	☐ No	Statement of Work	☐ Yes	☐ No
Project Abstract	☐ Yes	☐ No	Biographical Sketch	☐ Yes	☐ No
Technical Proposal	☐ Yes	☐ No	Cost Proposal/Budget	☐ Yes	☐ No
Current & Pending Support	☐ Yes	☐ No	Bibliography	☐ Yes	☐ No

______________________________ ______________________________

Date Signature of person authorized to sign for organization

______________________________ ______________________________

Date Signature of Principal Investigator

ARO Form 52
(Revised Oct 98)
USE THIS FORM FOR INDUSTRIAL CONTRACTORS

PROTECTION OF PROPRIETARY INFORMATION DURING EVALUATION AND AFTER AWARD

It is the policy of the US Army Research Office to treat all research proposals as privileged information prior to award and to disclose the proposal contents only for evaluation purposes. Technical evaluation of these proposals normally are made by highly qualified scientists from the Government and leading scientists and other preeminent experts outside the Government to ascertain their merits. If you wish, you may restrict the evaluation of your proposal to only scientists within the Government. To do so may prevent it from receiving an evaluation by those most qualified to evaluate it. Therefore, we ask permission to send your proposal outside the Government, if necessary, to obtain an unrestricted evaluation.

All reviewers are made aware that proposals sent to them for evaluation shall not be duplicated, used, or disclosed in whole or in part for any other purpose without the written permission of the offeror.

You should be aware that despite all precautions, we can protect the confidentiality of proprietary information contained in proposals only to the extent that it is exempt from disclosure under the Freedom of Information Act (FOIA; 5 U.S.C. 552). Generally, Exemption 4 of the FOIA [5 U.S.C. 552(b)(4)] will protect from release information submitted to the Government that constitutes either (1) a trade secret or (2) commercial or financial information which is privileged or confidential. Any such proprietary information contained in your proposal should be marked in accordance with FAR 15.608.

Please complete the following statement indicating your proposal treatment preference during the evaluation phase and, should a contract be awarded, afterwards.

STATEMENT OF DISCLOSURE PREFERENCE

________________________ in submitting proposal titled ________________________

(Organization)

________________________ with ________________________

(Name)

as Principal Investigator, requires the following procedure be used during its evaluation:

(   ) Permission is hereby granted to the US Army Research Office to evaluate this proposal in accordance with its normal procedures which may include evaluation by reviewers both within and outside the Government.

(   ) Restrict the evaluation of the above proposal to Government reviewers only.

To reduce administrative requirements, you may complete the following information by checking the appropriate blocks:

If this proposal results in a contract or grant, the offeror grants ARO the authority to release the following portion of its proposal in response to requests under the Freedom of Information Act, only after such award, without prior contact with the offeror.

Cover Page	☐ Yes	☐ No	Statement of Work	☐ Yes	☐ No
Project Abstract	☐ Yes	☐ No	Biographical Sketch	☐ Yes	☐ No
Technical Proposal	☐ Yes	☐ No	Cost Proposal/Budget	☐ Yes	☐ No
Current & Pending Support	☐ Yes	☐ No	Bibliography	☐ Yes	☐ No

____________________ Date

____________________ Signature of person authorized to sign for organization

____________________ Date

____________________ Signature of Principal Investigator

ARO Form 52A
(Revised Oct 98)
USE THIS FORM FOR EDUCATIONAL INSTITUTIONS AND NON-PROFIT ORGANIZATIONS

PROJECT ABSTRACT

The Project Abstract shall include a statement of objectives, methods to be employed, and the significance of the proposed activity to the advancement of knowledge or education. Avoid use of the first person to complete this summary. DO NOT EXCEED ONE PAGE. The abstract should be suitable for release under the Freedom of Information Act, 5 U.S.C. 552, as amended.

PROJECT DESCRIPTION

BIOGRAPHICAL SKETCH

Provide the following information for the senior personnel on the project. Begin with the Principal Investigator/Project Director.

DO NOT EXCEED THREE PAGES PER PERSON

NAME: **POSITION TITLE:**

RESEARCH AND PROFESSIONAL EXPERIENCE:

THE FOLLOWING ADDITIONAL INFORMATION IS REQUIRED:

A. List up to 5 publications most closely related to the proposed project and up to 5 other significant publications, including those being printed. Patents, copyrights, or software systems developed may be substituted for publications. Do not include additional list of publications, invited lectures, etc.

B. List of persons, other than those cited in the publication list, who have collaborated on a project or a book, article, report or paper within the last 4 years. Negative reports should be indicated.

C. Names of graduate and post graduate advisors and advisees.

The information in B. and C. is used to help identify potential conflicts or bias in the selection of reviewers.

BIBLIOGRAPHY

CURRENT AND PENDING SUPPORT

The following information should be provided for each investigator and other senior personnel. Failure to provide the information may delay consideration of the proposal.

Investigator:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate:) $ Period Covered:
Location of Research:
Person-Months Committed to the Project: Cal: Acad: Summer:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate:) $ Period Covered:
Location of Research:
Person-Months Committed to the Project: Cal: Acad: Summer:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate:) $ Period Covered:
Location of Research:
Person-Months Committed to the Project: Cal: Acad: Summer:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate:) $ Period Covered:
Location of Research:
Person-Months Committed to the Project: Cal: Acad: Summer:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate:) $ Period Covered:
Location of Research:
Person-Months Committed to the Project: Cal: Acad: Summer:

---

* If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

USE ADDITIONAL SHEETS AS NECESSARY

FACILITIES, EQUIPMENT, AND OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, briefly indicate their capabilities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. Use additional pages, if necessary.

Laboratory:

Clinical:

Animal:

Computer:

Office:

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate, identify the location and pertinent capabilities of each:

ADDITIONAL INFORMATION: Provide any other information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual/subaward arrangements with other organizations.

SUMMARY
PROPOSAL BUDGET
YEAR-

OFFEROR						
PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR (PI/PD)						
A. SENIOR PERSONNEL, PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in parentheses)	Man Hrs/Mos	Rates	-Mos			Funds Requested by Offeror
			CAL	ACAD	SMR	
1.						
2.						
3.						
4.						
5.						
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION)						
7. ( ) TOTAL SENIOR PERSONNEL (1-6)						
B. OTHER PERSONNEL (SHOW NUMBERS IN PARENTHESES)						
1. ( ) POST DOCTORAL ASSOCIATES						
2. ( ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)						
3. ( ) GRADUATE STUDENTS						
4. ( ) UNDERGRADUATE STUDENTS						
5. ( ) SECRETARIAL - CLERICAL (If charged directly)						
6. ( ) OTHER						
7. TOTAL SALARIES AND WAGES (A + B)						
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.00. ATTACH ADDITIONAL EXPLANATION PAGES, IF NECESSARY.)						
TOTAL PERMANENT EQUIPMENT						
E. TRAVEL (LIST ON BUDGET EXPLANATION PAGE)						
1. DOMESTIC (INCLUDE CANADA, MEXICO, AND U.S. POSSESSIONS)						
2. FOREIGN						
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 2. TRAVEL 3. SUBSISTENCE 4. OTHER						
( ) TOTAL PARTICIPANT COSTS						
G. OTHER DIRECT COSTS (ITEMIZE ON BUDGET EXPLANATION PAGE)						
1. MATERIALS AND SUPPLIES						
2. PUBLICATIONS COSTS/DOCUMENTATION/DISSEMINATION						
3. CONSULTANT SERVICES						
4. COMPUTER (ADPE) SERVICES						
5 SUBAWARDS						
6. OTHER						
7. TOTAL OTHER DIRECT COSTS						
H. TOTAL DIRECT COSTS (A THROUGH G)						

I. INDIRECT COSTS		Rate	Base	Total	
	Overhead				
	G&A				
	Fringe				
TOTAL INDIRECT COSTS	FCCM				

J. TOTAL DIRECT AND INDIRECT COSTS (H + I)	
K. FEE (%) BASE $	
L. COST SHARING	
M. AMOUNT OF THIS REQUEST	

PI/PD NAME (TYPED) & SIGNATURE	DATE
OFFEROR'S AUTHORIZED REP. NAME (TYPED) & SIGNATURE	DATE

CONTRACT FACILITIES CAPITAL COST OF MONEY

Form Approved
OMB No. 0704-0267
Expires Mar 31, 2001

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1. CONTRACTOR NAME	2. CONTRACTOR ADDRESS
3. BUSINESS UNIT	
4. RFP/CONTRACT PIIN NUMBER	5. PERFORMANCE PERIOD

6. DISTRIBUTION OF FACILITIES CAPITAL COST OF MONEY

POOL a.	ALLOCATION BASE b.	FACILITIES CAPITAL COST OF MONEY c.	
		FACTOR (1)	AMOUNT (2)
d. TOTAL			
e. TREASURY RATE			%
f. FACILITIES CAPITAL EMPLOYED (TOTAL DIVIDED BY TREASURY RATE)			

7. DISTRIBUTION OF FACILITIES CAPITAL EMPLOYED

	PERCENTAGE a.	AMOUNT b.
(1) LAND	%	
(2) BUILDINGS	%	
(3) EQUIPMENT	%	
(4) FACILITIES CAPITAL EMPLOYED	100%	

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